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THE SIGNS OF THE TIMES.

By Edward Atkinson.

I HAVE been asked to call attention to some of the salient points in the present condition of affairs in this and other countries upon which one may base a long look ahead. Such forecasts are of no immediate application in the conduct of the daily or even the annual transactions of business men ; they are of no use to men of affairs who must watch the variations of each season and the temporary, but often very severe, checks to immediate progress. Commercial and financial crises, due to ordinary causes, affect immediate transactions, but few have any permanent influence. Legislative tampering with the currency, coupled with efforts to debase the unit of value, retard constructive enterprise and exert a disturbing influence of longer duration, but in a country of such unlimited productive power as our own the real forces on which material progress must be predicated are superior to these temporary aberrations, and in the end control events. We are now emerging from one of these malignant periods, but upon every side the evidence is plain that we have wrested benefits even from the hard times to which we have been subjected by the incapacity of congress. These benefits will have been gained at the cost of much individual distress, yet the nation has made a vast advance in productive energy, even in the last 2 years.

Few yet comprehend the meaning of the transfer of the paramount control of the production of iron and steel from European States to this country. The hard times of the last 2 years have rendered that control more absolute than it might have been except these hardships had been brought upon us.

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One writing for special readers, especially for engineers, may deal with this subject in a way that might not be interesting to the general public.

In 1890 I ventured upon a forecast of the production and consumption of iron in the year 1900 which has lately been treated as a very extravagant one. While I was engaged upon this work, Mr. A. S. Hewitt sent me an article written by himself in 1856, containing a forecast of the future which in 1890 had been even more than sustained. In that pamphlet Mr. Hewitt based his reasoning upon the following statement of the facts of that date,—1856.

"Assuming the population of the world to be 900,000,000, the production, and, of course, the consumption, of iron is at the rate of about 17 lbs. per head. In 1740, when we have the most reliable data, the consumption of iron did not amount to 1 lb. per head. But the great fact to which I wish to call your attention, in order to produce the practical results at which this paper aims, is the distribution of the present consumption among the nations of the world. In order to determine this point, I have made very careful calculations, which show the following result:

Nations.	Production per head.	Consumption per head.
England	287 lbs.	144 lbs.
United States	84 "	117 "
France	40 "	60 "
Sweden and Norway	92 "	30 "
Belgium	136 "	70 "
Austria	12½ lbs.	15 "
Russia	10 lbs.	10 "
Switzerland		22 "
Prussia	50 "	50 "
Germany, Zoll Verein	50 "	50 "
Spain	4½ lbs.	5 "

Turkey and the uncivilized portions of the world too little to be calculated.

Upon these facts Mr. Hewitt predicated his forecast, calling attention to their meaning in the following terms:

A careful examination of this table will demonstrate conclusively that the consumption of iron is a social barometer by which to estimate the relative height of civilization among nations; for, considering in what practical civilization consists (I exclude esthetic civilization from this species of estimates), measuring by the actual comforts and conveniences with which social life is surrounded, what philosophic traveler or student will not classify the nations of the world precisely as the table arranges them: England first, United States second, Belgium third, France fourth, Germany fifth, Switzerland and Sweden about on a par, Austria next, then Russia, Spain, and Turkey, and the great outlying regions of barbarism? You will not fail to observe another fact,—that the large consumers are large producers in every case,—a fact which a little familiarity with the laws of trade and industry will show to be inevitable.

Without any previous knowledge of Mr. Hewitt's analysis, the writer had made the following analysis of the consumption of iron, which is a better social standard or barometer, because its production is not a very desirable occupation. It is, however, true that the pro-

duction in greatest measure leads to the largest consumption. It is therefore a necessary factor in the subsequent analysis.

CONSUMPTION OF IRON, 1870 to 1890.

In 1870 to 1878, inclusive, the average consumption of iron per capita by the people of the United States, as nearly as it can be computed, did not exceed ..... 150 lbs.
In 1879, taken separately, it was approximately ..... 200 "
In 1889 it was in excess of ..... 300 "
In 1889 the consumption or use of iron in Great Britain, France, Germany, and Belgium, after making allowance for the relative import and export of each country, did not exceed per capita ..... 175 "
If there were upon the globe in 1889 about 1,200,000,000 people aside from the population of the foregoing countries, then their average consumption of iron did not exceed per capita ..... 11 to 12 "

From the authorities consulted it would appear that the production of the United States, Great Britain, France, Germany, and Belgium has long been approximately a little over 90 per cent. of the commercial iron product of the world. The product of these specific countries was substantially as follows:

1856	6,000,000	gross tons
1867	8,400,000	" "
1878	12,750,000	" "
1889	22,800,000	" "

The price of anthracite foundry iron in Philadelphia was as follows:

1856	$27 1–8 net ton, in gold.
1867	44 1–8 " " " currency.
1878	17 5–8 " " " gold (practically).
1889	17 3–4 " " " "

It will be observed that the increase in production from

1856 to 1867 on rising prices was ..... 40 per cent.
1867 to 1878 on declining prices was ..... 50 " "
1878 to 1889 on variable, but generally lessening, prices was 80 " "

These facts make it apparent that, in spite of lessening or variable prices, the great improvements which have been applied to the science of iron-making have enabled the owners and managers of mines and works to meet the accelerating increase of demand, notwithstanding the great advance in wages both in Europe and in the United States between 1856 and 1889.

Summary of consumption in round figures and gross tons in the year 1889.*

* This estimate was based upon the actuarial computation of the population of the United States in 1890 before the census had been taken. Were the census figures used as a divisor, the per capita consumption of iron would appear to have been a little more. My own judgment has always been that the actuarial computation was probably nearer the mark than the actual enumeration, there appearing to be no sound reason for the abnormal retardation of the increase of population between 1880 and 1890.

	Population.	Per Capita.	Tons.
United States.....	64,000,000	300 lbs.	8,500,000
Great Britain, France, Germany, and Belgium..	136,000,000	175 "	10,500,000
All the rest.....	1,200,000,000	11 "	6,000,000
Total.....	1,400,000,000	40 lbs.	25,000,000

Upon that analysis the writer based his forecast of 1890, which is even more applicable to the present time when we are emerging from the period of temporary retardation in our progress, in which the consumption of iron has been reduced. With some slight changes the argument of 1890 will now be repeated.

The conversion of iron into railroads and steamships and the opening of commerce and the development of industry in specified countries, coupled with the increase of commerce between countries now connected by railroad and steamship more intimately than ever before, while creating an enormous primary demand for iron and steel in laying the railroad and building the ships, yet develops a constantly increasing secondary demand for iron and steel for other uses, —*i. e.*, for structural purposes, stationary engines, machinery, and tools of every name and nature. Thus it happens that, while the development of the ways of commerce has, at the beginning, created an enormous demand for iron and steel, subject to considerable fluctuation according to the activity or depression in constructing railroads or vessels, yet, in the last 2 years (1888 and 1889) in which the construction of railroads lessened in comparison with the immediately preceding period, especially in the United States, the increase of the demand for iron for other purposes (now, 1895, including electric railways) has more than counterbalanced the diminishing demand for that purpose, and the advancing tendency of prices on what may be called the normal demand of the world has very lately been developed.

Let us then put questions in regard to the future status of each of the great sections of the world included in the above table. Who will answer them?

In respect to the United States, is it not almost certain that the consumption of iron will go on increasing, subject to temporary variations, in the period which will elapse between 1890 and 1900, —not only in the present ratio to the population, but also in an accumulative measure corresponding to the increase per capita which was developed between 1877 and 1889? Let it, however, be assumed that the increase per capita will rise only from 300 to 400 lbs. per head; then the 80,000,000 of people who will occupy this country in the year 1900 may require, in addition to our present supply, not less than 7,000,000 gross tons.

If the demand of Great Britain, France, Germany, and Belgium shall increase only 20 per cent. in the next 10 years,—1890 to 1900,—that increase will create a demand, in addition to their present consumption, for 2,000,000 tons.

If the consumption of the rest of Europe, of Asia, of Africa, of South and Central America, and of Australia shall carry their demand only from 11 or 12 lbs. per capita to 22 or 24 lbs., then, in addition to their present supply of 6,000,000 tons, they would require 6,000,000 more.

A summary of these conclusions will make the prospective demand of the world in the year 1900 stand as follows:

Present production (1890) based on the figures of 1889.....	25,000,000 tons.
Increased consumption in the United States.....7,000,000	
Increased consumption in Great Britain, France, Germany, and Belgium.....2,000,000	
Increased consumption in all the rest of the world.....6,000,000	
Total increase of demand.....	15,000,000 "
Total supply required in the year 1900.....	40,000,000 tons.

This forecast of 1890 of an accelerating demand far beyond the increase of population was justified by the conditions of the years 1891 and 1892, but the financial panic of 1893, due to the attack upon the credit of the country and the threatened debasement of the unit of value, almost stopped constructive enterprises. The reduced consumption of iron in 1893 and 1894 bears witness to the social disorder which ensued, fully justifying Mr. Hewitt's measure of the importance of this social barometer. We are now emerging from that period of disaster, and constructive enterprise is now being resumed.

Although the demand for iron and steel for railway construction is relatively less important than it was in the periods previously dealt with, it is yet a factor which calls for separate treatment.

In 1881 the writer dealt with the standard of adequate railroad service. At that time the unit chosen was the mileage of Massachusetts, possessing within her area 1 linear mile of railroad to each 4 sq. miles of territory,—all save one small section of this mileage then and subsequently profitable both to their owners and to the State. Taking that unit as the standard of adequate service, the territory of the United States was divided into several sections, and, forecasting their need down to the year 1900 from January 1, 1880, the requirements of the several sections were put as follows:

Section No. 1, 1 mile of railroad to 4 sq. miles.
No. 2, 1 to 8.

No. 3, 1 to 16.
No. 4, 1 to 32.
No. 5, 1 to 64.
No. 6, indefinite.

Upon that basis the future requirement of railroads starting with a little under 93,000 miles in service called for 117,000 miles to be added by January 1, 1900. The average from January 1, 1880, to January 1, 1893,—13 years,—exceeded the estimate, being about 6400 miles a year. In 1893 and 1894 the silver agitation stopped the necessary construction of railroads, with the effect that in 2 years we have not added as many as ought to have been added in 1 year to meet an absolutely necessary demand. Yet, adding these 2 years of disaster, and computing the miles of railroad in operation January 1, 1895, at 180,000 as compared with January 1, 1880, 93,000, the forecast of 1881 has been justified. It is not improbable that the 30,000 miles called for to meet the needs of the country January 1, 1900, will yet be added, bringing the mileage on January 1, 1900, to about 210,000. Basing our anticipations from January 1, 1896, it may be remarked that future construction will be on a cash basis, not on a speculative or inflated basis, and that by so much as railroad construction has been retarded in the last 2 years may it be accelerated in the next 2 years; subsequently construction will go on at a normal rate.

A very large addition to the railroad service is now projected. How much the increase may be in the present calendar year (1895) does not yet appear. It does appear, however, that in the next year the average of the last 15 years of about 6000 miles per annum may be renewed, especially in the States and territories from which capital has been excluded for several years by the discredit due to congressional action. Taking Texas as an example, there is no reason why that State should not rapidly approach the railroad mileage of other sections in the middle West less well endowed with resources. That would require 40,000 miles of railroad in that one State, which now has less than 10,000. The causes of discredit and the distrust of the people of Texas will presently be removed by ejecting from congress their misrepresentatives who have tampered with the unit of value. Alabama is a very productive State, where railroad construction has been retarded; her people are moving upon the same lines. Georgia has not been so much discredited, but needs to take the same action. Yet more, States and territories in the far West—Oregon, Washington, Montana, and Idaho—will presently eject from congress men who have discredited their States, and among them will be the senator who made the unblushing avowal to the writer, when a protest was entered against

his action on the free coinage of silver: "Of course I know better. I don't believe all the d—d rot, but I have got to vote for it."

The more probable course of political events will be that, under the impulse of the prosperous conditions which are now in sight, men of ability, as some of these misrepresentatives are, will see the error of their ways, and will sustain sound-money measures, leaving the little faction from the silver mining camps to save themselves from derision as well as they can.

It therefore follows that, dating from January 1, 1896, it will become necessary to add railroad mileage to our present service at the rate of not less than 5000 or 6000 miles a year for many years to come, in order to give a partly adequate service to these very productive areas of our national domain which are now suffering from their own discredit. Not less than 100,000 miles of new railroad must be constructed in the next 15 or 20 years.

This extension will not consist of great through lines, which may be called the warp of our system, but of cross lines and connections, which make the weft. Bearing in mind the relative resources of the two sections, one may contrast the present totally inadequate railroad service of Texas of less than 10,000 miles with that of an area but a trifle greater in the States of Ohio, Indiana, Illinois, Iowa, and Kansas, which have 44,000 miles.

On the other hand, the demand upon the iron and steel furnaces for rails for new railroads is no longer the most important factor. At the lessened prices of steel the demand for the purpose of constructing buildings and for many other kinds of work in which wood and other materials have been used is becoming the paramount factor. The rule of accelerated demand out of all proportion to increase of population is now more potent and subject to more rapid development than ever before. That rule is affecting the consumption of all nations.

Where will this increasing demand be met? Great Britain has depended mainly for fine or bessemer metal upon the ores of Spain, near Bilbao, where the deposit is nearly exhausted. Her supply of coking coal is lessening, and the cost is increasing. When her furnaces depend upon the ores of Africa, the South of Spain, and the Arctic regions of Sweden, the haul of ores to the furnaces will be more costly than from our Lake Superior mines to the lake ports or to Pittsburg. Our supply of coke is in excess of any possible demand; it is produced at much higher wages and at half the cost of British coke, mining and handling requiring very much less labor.

We may also anticipate a very great increase in the consumption of iron and steel in the construction of vessels. There have been two causes for the relative increase of British naval construction and the

reduction of our own. We had the advantage in building ships of timber. Subsequently iron and then steel ships took the place of wooden vessels. The disparity in the price of crude iron between this country and Great Britain, down to a very recent period and for a long term of years, averaged $7 per ton. This disparity was caused by duties on imports, but was somewhat less than the rates of duty, yet more than sufficient to protect the British ship-builders and forbid competition here. Our present duties have become inoperative, since we now produce iron and steel in many places at a less cost than in Europe; the advantages which we possess in other directions will presently turn a large part of the construction of ships to this country.

One obstruction is yet to be removed,—to wit, the duty on the bessemer ores of Cuba and on the coal and scrap iron on which New England formerly depended in many works before her iron industry had been destroyed by our tariff policy; this change will remove our only present disadvantage in the construction of vessels for ocean service. Our ships of war, especially the naval vessels which bear the disgraceful name of "Commerce Destroyers," have given evidence of the capacity of our ship-builders to master the principles of construction coupled with high speed. When that skill is devoted to the protection of commerce, to which the barbarous conception of destroying commerce must give way, we may resume our due proportion in this branch of productive work, but we shall not attain full supremacy until the second obstruction is removed,—namely, the obsolete, but onerous, provisions of our navigation acts.

The domestic consumption of iron is now estimated at approximately 350 lbs. per head, justifying the forecast of 1890. The population at the present time is, in round figures, 70,000,000. At 350 lbs. per head the requirements for the next 12 months would be within a fraction of 11,000,000 gross tons,—a little over 12,000,000 net tons. One-eighth of our consumption, however, is derived from old scrap iron and steel, old rails, car-wheels, etc. This will reduce the demand upon iron furnaces to about 9,500,000 gross tons, or a little over 300 lbs. per head of new iron.

I should not myself have ventured to put the present consumption quite so high, but I am permitted to cite the authority of Mr. James M. Swank, the able secretary of the Iron and Steel Association, on this point.

A few words may be given to the consumption of other countries. The financial difficulties which have affected Australia and South America have exerted a very adverse influence upon the demand for British and German iron. These financial difficulties are now being surmounted, and a new start has been given to the productive energy

of the Argentine and other South American countries and to the colonies of Australia. To their demand will be added that of Africa, and especially of South Africa, which is now making such rapid development. It is not probable that there will be any considerable increase in the per capita consumption of iron in England or in continental States. The burden of passive war and the heavy taxes imposed for the support of armies forbid any considerable industrial progress, while on the continent of Europe, with the development of the land armaments, it is becoming manifest that the battle-ships and other armed ships of war, so many of which have lately been on review at Kiel, are practically worthless for offense or defense, and may soon be concealed in the grave-yards of iron-clads corresponding to the harbor of Bermuda, where there is already a great collection of iron-clads of the type of a few years since. Where the Germans, French, and Italians may hide their examples of ignorant and wasteful expenditure on these lines is not yet manifest.

There is something rather grotesque in the picture which the nations have made at the opening of the ship-canal at Kiel. The object of that canal is mainly to promote commerce, to facilitate exchange, to bring to the occupants of a rather poor soil in middle Europe a necessary supply of food and fibres from other parts of the world, and also a necessary supply of the crude products of the non-machine-using nations for conversion into finished goods for home use and export. In order to celebrate the opening of this peaceful way for commerce, there gathered a collection of naval bull-dogs, each for the time muzzled, but in many instances with growl barely suppressed. In a rough-and-ready way one may estimate the cost of this fleet of 100 great armor-clad ships of war, with 25 lesser vessels, at approximately $200,000,000, which is probably four or five times the cost of the peaceful water-way the opening of which they were called together to celebrate. The United States was represented by one battle-ship and, I believe, by one of our two "Commerce Destroyers," so-called. The two armored ships so named cost nearly $7,000,000,—a sum nearly equal to the entire endowment of Harvard University,—while the annual expense of keeping the two in commission is nearly as great as the pay-roll of the same University. The only commerce of any importance upon which these destructive ships of war could exert their force would be that of Great Britain and Germany, our two largest foreign customers for the excess of our farm products, which would rot upon our fields if we could not sell them for export. Any commentary upon these grotesque conditions would perhaps be superfluous.

In striking contrast to the demonstrations at the opening of this canal, one may refer to the canal at St. Mary's falls through which

the commerce of the great lakes passes to the Welland canal and to the superfluous canal which Canada has just constructed nearly parallel to our canal on the other side of the way. The annual tonnage passing through the St. Mary's canal connecting our great lakes exceeds that which passes through the Suez canal every year by more than 25 per cent. Neither of these canals is guarded by forts or armor-clad vessels; the simple agreement entered into by President Monroe and the British government in 1818 forbids the construction of any ships of war upon the great lakes. That is a true Monroe doctrine, which the Jingo element in our politics might well regard. The purpose of that agreement, as distinctly stated on both sides, was "to avoid collision and to save expense." Not a word may be said against the construction of a few swift cruisers to protect the commerce of the United States in distant places. Such vessels although armed, are entitled to the name of "Commerce Protectors."

As time goes on, this waste of preparation for war will be stopped in more than one way.

First, because no ship can carry armor which will defend it from the latest type of guns.

Next, because no land force can stand in the face of guns discharging over six hundred shots per minute warranted to kill at more than a mile.

But lastly, as to European States, because the limit of taxation has been reached. New taxes cannot be invented, and new sources of revenue cannot be discovered, which will warrant even the maintenance of existing armies and navies. The burden of militarism is borne mainly by the machine-using nations and States of Europe, with which this country is about to enter into more urgent competition than ever before. The only group of machine-using nations which now has any chance of success in competing with this country, either in supplying us with any of the manufactured goods that we require or in supplying other nations with the useful products of machinery, consists of Great Britain, the Netherlands, Germany, and France. Their ability to compete may be measured by their relative consumption of iron; their inability to compete may be measured by the burden of the withdrawal of men from useful service to fill the camps and barracks where they are supported each by the labor of another and by the unbearable burden of taxation which can no longer be safely borne.

All modern commerce rests upon a fraction of profit on each unit of product. In that nation, State, or section in which skilled labor is applied to the use of machinery under the safest conditions the product will be greatest, the price of the product will be lowest, and the wages of workmen will be the highest. These are correlative terms, each

the complement of the other. The burden of taxation then comes in. It is to be measured, not by its ratio to the gross cost of the thing taxed, but by its ratio to the lessening margin of profit by which production is induced. So far as I have been able to investigate this somewhat obscure subject, the tax imposed by this country for all national purposes at the present time does not exceed 2½ per cent. upon our product. That of Great Britain is more than 6 per cent. That of the Netherlands, France, and Germany is more than 10 per cent. That of Italy, which I have not yet named, takes so large a share of the product as to have reduced some sections of the country to conditions of disease merely for lack of suitable food. That is the price paid by nations in order to enable them to send $200,000,000 worth of useless and worthless armored vessels to celebrate the opening of a peaceful canal.

The subject of relative taxation in proportion to the product is one to which I can only refer in preparing the conclusion of this treatise on the "Signs of the Times."

It may be remarked that, if these ratios of the relative burden of taxation to profits, which I believe to show much less than the real advantage of this country, are sustained by the facts, their import is profound. This country is the only machine-using nation which produces food, fuel, metals, and fibres far in excess of its own wants. If to that advantage is added a difference in the burden of national taxation corresponding to the previous figures, there can be no competition on the part of other countries with this country in making any products, except those that depend either upon fashion and fancy for their sale or upon the skill of the handicraftsman for their production. These fabrics are relatively unimportant and insignificant in comparison with the great mass of useful goods which the world is calling for in increasing quantity. Capital has accumulated in recent years faster than ever before, especially in this country. Anything that shows a gross profit of 10 per cent. would be instantly taken up by capitalists for development. Therefore, when useful goods show a profit of 10 per cent., free of national taxation, the ratio of our national taxes to that profit is two and a half to ten; in Great Britain, at least six to ten; in France and Germany, ten to ten. That is to say, our rate of national taxation takes only two and a half parts from a gross profit of ten; other things being equal, the British national taxation takes six parts from ten; in France and Germany national taxation takes the whole. But other things are not equal; the advantage is with us. Manifestly the capital and the skilled workmen will tend year by year to that section of country in which the highest wages can be earned by converting the greatest abundance of crude products

into finished goods under the least burden of national taxation. Yet Great Britain will retain her supremacy in manufactures and commerce if she maintains her standard or unit of value, the pound sterling, and we do not maintain our own. When we surely establish the unit of value in this country so as to give equal confidence in its maintenance and in its integrity, we shall assume our paramount position in the production and distribution of all useful fabrics. Possessing, as we do, the power to produce food, fuel, fibres, and metals in excess of all our wants; enjoying absolute free trade on a continental scale over a larger area and among a greater number of people than ever before secured that great advantage; and holding the control and use of practically unlimited supplies of the ores of iron and copper upon which the commercial world must soon rest for its principal supply of these metals,—our dominion is established.

Motley tells the story of the people of the Dutch Republic, who, producing not a grain of wheat within their borders, ate the whitest bread of Europe. Even so the people of this republic would command the treasures of the world, though not an ounce of gold had been found in any part of our domain. While Europe is ruled by "blood and iron," we may hold a pure control over all nations in the pursuits of peace and welfare by the use of our iron, and yet not shed one drop of blood.

Ense petit placidam sub libertate quietem.

THE TROLLEY IN COMPETITION WITH RAILROADS.

By Clarence Deming.

ADDED to causes more obvious and general have been special ones, both physical and economic, which have made Connecticut an alluring field for electric enterprise. The State itself, abounding in surplus capital, albeit somewhat conservative, lies between and near New York and Boston, open to the overflow of investment funds from those money centres and without that drawback of remoteness in the financial venture which of late years has been checking the westward flow of eastern capital. There are eighteen cities in the commonwealth, containing probably not less than 65 per cent. of the population. Of those eighteen cities fifteen are in five of the eight counties. Three counties—New Haven, Hartford, and Fairfield—included by the last census about 68 per cent. of the total population, and have a still larger portion to-day. Testing still farther the urban centrality of population which favors the development of transit systems, it will be found that the maximum distance from any Connecticut city to the city proximate is between Danbury and Norwalk,—about 23 miles by rail,—while, as a measure of minimum inter-urban distance Norwalk forms physically one city with South Norwalk, as does Ansonia with Derby. A population of more than 200,000 fringes the shore for about 45 miles between Greenwich and New Haven, and between the latter city and Hartford, both inclusive, a population almost as large dwells along an interior straight line of some 36 miles. There are, outside of the cities, twenty-one borough towns, ranging from 2235 to 10,131 in population, and all through the State prevails the familiar New England drift from the country regions to the city or factory town. The thickly-settled factory valleys of the interior and the level areas of lower Connecticut offer easy grades for railroad construction. If we consider all these conditions, we find that no American State, with the possible exception of New Jersey, has offered a more attractive natural field than Connecticut for electrical venture.

The obstacles to the trolley in the State have been twofold: first, that tenacity of property rights so marked in New England communities, and revealed in Connecticut, not so much in the cities, as in the opposition to the surrender of the highways outside of them; second, and of much greater moment, the resistance of the steam-railroad cor-

porations, which own or control properties representing not less than $200,000,000 at present market values. How paramount in the State legislature has been the highly-organized lobby of the New York, New Haven and Hartford (the "Consolidated") railroad company is too trite a fact to need fresh description. But as an exponent of the general as well as localized powers, at the State capitol, of the Connecticut steam-railroad corporations, it may be stated that, out of 168 townships in the State, 135 are bisected by one or more lines of steam railroad. Except one short line of a semi-private character and the New London Northern road, which is allied with the Vermont Central system, the Consolidated and the New York and New England Company own or control every mile of steam-railroad track in Connecticut, besides two of the great lines of Sound steamboats with terminals in the State. If the Consolidated Company alone, often with the New England Company as a foe, has been all but able to dominate legislation, one can imagine the influence at the State capitol of all the steam companies when joined together against electric innovation when it has menaced their interests. The conflicts of the two have made Connecticut a battle-ground of the rival systems.

Connecticut legislation has been so serious in its bearings on the trolley roads that a brief sketch of it, up to and including 1893, is timely, the general work of the present legislature being left for later review in this article. Before 1890 there had been but two experiments in electric transit, both on short local lines with clumsy equipment. They were not popular, and later reports of the "trolley nuisance" from outside cities intensified the dislike. As a sample of the popular feeling, the promoters of a new street railroad in New Haven, seeking a charter from the legislature of 1889, could obtain it only by inserting a special proviso against electrical equipment. But the future of electricity was forecast, and a large number of new projects awaited the authority of the next legislature of 1891,—so many that, when the partisan deadlock which made the session a blank began in that year, it was predicted freely that the electrical interests would force a settlement. But no settlement was made, and the effect of the legislative *hiatus* of 2 years was to mass new enterprises for the next general assembly,—that of 1893,—on which they descended in a flood. They were resisted stoutly by the steam companies, but, by alliance with the "granger" element in the lower house, won a victory—on a question of the powers of the railroad commission over new trolley projects—which forced, as a compromise, the general electric law now on the statute-books of the State. Its most salient provisions are: (1) local control—by mayors and common councils in cities, wardens and burgesses in boroughs, and selectmen in towns—

of layout, track, speed, and equipment of electric roads; (2) compulsory maintenance by the company of the street between tracks and of 2 ft. on each side; (3) right to carry both passengers and freight on approval of the superior court; (4) parallels of steam roads to be amenable to the same jurisdiction—with power of appeal on questions of law to the supreme court; (5) towns, cities, and boroughs, as well as the companies, to be liable in certain cases for damages; (6) the word "street" to include bridges; (7) registration of all bonds with the State comptroller, and bonding to be limited to three-quarters the cost of construction and equipment, this clause, however, allowing special charters to override the bonding safeguard, and thus giving rise to dangers which have been realized; (8) compulsory exchange of traffic under orders of the courts; and (9) annual returns to the State railroad commission. By a statutory flaw, however, returns were ordered on October 1 of each year up to and including the day before. This has essentially nullified the provision of the statute for returns, and made a travesty of many of such returns as have been handed in; and in consequence there are now few trustworthy official statistics of Connecticut street railroads and no official compilations.

The legislature of 1889 passed a bill which prohibited grade-crossings of steam railroads by horse, cable, and electric roads. But in the next working legislature of 1893—the deadlock having intervened—the electric companies secured a modification of the law, so as to legalize those crossings, if approved by the railroad commission. That body, which, from the first, had opposed the crossings, while allowing them in some cases, took a rather resistive attitude. Then a long and sharp legal contest ensued over the question of the right of electric companies which by charter had been granted the special privilege to cross at grade to override the general law. In the test case—that of the Bridgeport Traction Company against the Consolidated Company, involving a very dangerous grade-crossing at Bridgeport—the latter corporation won in the lower court, but, by a divided bench of three judges to two, was defeated on appeal, one of the points raised being the priority in time of operation of the charters as against the general statute. Meanwhile great popular opposition had arisen against grade-crossings of steam and electric roads, and at the end there was a kind of race between the legislature and the traction company, which needed the court's final order before laying its rails. The legislature won; a terse bill absolutely prohibiting grade crossings was literally "railroaded" through the general assembly, and is the law to-day. Though popular and justified, the new statute favors plainly the steam companies with their established lines, and it is predicted that in certain cases, by laying short spur tracks from their

lines, they may be able to pervert to their own vantage as against trolley parallels the benefits derived from the new prohibitory statute.

While, owing chiefly to the legislative deadlock, the period of active electrical expansion has spanned but a little more than 29 months, the statistics of growth are impressive. In January of 1893 there was in single track a total of 147 miles (approximately) of street railroad in the State, of which about 81 miles were operated by horse power and 66 miles by electricity. There are now about 289.7 miles, of which all but two short roads with some 5 miles of track are electrically equipped. A list of the separate roads, companies, and systems is exceedingly difficult to compile, owing to the rapid changes; but, so far as such a list can be made from the supplement of the *Street-Railway Journal*, with some additions, it is annexed:

	Single track miles.
Bridgeport Traction Co.	45.0
Danbury and Bethel	7.2
Derby Street Railway Co.	.50
Hartford Street Railway Co.	35.0
Hartford and West Hartford	14.0
Meriden Railroad Co.	17.0
Middletown Railroad Co.	4.5
Central R. R. and Traction Co. (New Britain)	12.0
Fair Haven and Westville	15.4
New Haven and Centreville	2.7
New Haven Street Railway Co.	21.8
Winchester Avenue	16.4
West Shore	3.8
New London Street Railroad Co.	7.2
Norwalk Street R. R. Co.	5.0
Norwalk Tramway Co.	12.5
Norwich Street R. R. Co.	12.5
Southington and Plantsville	1.8
Stamford Street R. R.	7.0
Waterbury Traction Co.	11.0
Westport and Saugatuck	1.7
Hartford, Manchester and Rockville	16.0
Hartford and Poquannock	10.0
Bristol and Plainville (in construction)	4.5
Total	289.7

Actual investment in street-railway properties of the State it is impossible to compute. The latest statements of the corporations show roughly an issued capital stock of $8,566,000, and bonded debt of about $6,662,000. But, owing to stock inflation, the actual investment is far below the total ($15,228,000) of the two. The old roads, when electrically equipped, have shown the wonted increase of business. For example, one important line, on an increase of mileage of

57 per cent., returns for 1894 (electric) over 1893 (horse) a gain of 72 per cent. in gross earnings ; another line, of about 12.5 miles, shows, with an increased mileage of 14 per cent., a gain of 81 per cent. in 1895 (electric) over 1894 (horse) ; while a small road shows for the same years a gain of more than 100 per cent. for electricity, with an increased mileage of but 29 per cent.

The figures for total mileage in the State show about 97 per cent. increase in single-track miles within the period of 29 months. In January of 1893 there were twenty-two distinct street-railroad corporations operating their lines. There are now not more than 24, although single-track mileage has increased 97 per cent., showing the swift process of both extension and absorption which has followed the introduction of the trolley. The increase in not a few cases has been too speculative. New roads too often have been built, crudely and crudely equipped, "financed" on bonds under "special" charters, while the stock has been held with partial or even no payments at all, and to a degree the first impacts of the trolley, under the auspices of foreign capital, have duplicated the kiting epoch of steam-railroad building brought to so disastrous a climax in 1873. To these reasons for financial and popular criticism have been added the hawking of charters and a tendency to "grab" streets, to invade municipal politics, and to tamper with city councils. But, despite these flaws of character and conduct, the new motive power has enjoyed a high popularity that is still rising. Speed, odors diminished if not eradicated, no stress of horseflesh, comparative smoothness of operation, may merely be named here as factors of popularity not limited to Connecticut, and to which may be added, as a more localized element, a large immunity from accidents, either serious or many, to be charged, perhaps, to good luck rather than to conservatism.

Of "projected" trolley roads—using the quoted word in its most ample sense, from actual layout to speculative hope—there are about forty-one enterprises in the State, reaching over some 381 miles of single track, some of them extensions. A good many of them have been smitten hard in the present legislature, but a system which contemplates a new mileage about 32 per cent. larger than that of all the street railroads already built in the State can be pruned much and still be portentous. In view of its size and ambitions, perhaps the organized resistance of the steam companies in the lobby and their sway over the legislature, while revolting to the ideals of representative citizenship, have not been unmixed evils.

The effect of trolley roads in the State as parallels of the steam lines is a subject upon which clearer light is thrown than on some other phases of the steam-trolley problem. Counsel of the Consoli-

dated road has presented at a committee hearing in Hartford the annexed figures of loss in number of passengers for the two periods of 6 months each, ended with February of 1894 and February of 1895, to show the effect of parallel competition up to that time :

			1894.	1895.	Decrease. Number.	Per cent.	Miles.
Bridgeport	and	Stratford	23,547	7068	16,479	.6998	3.2
New Haven	"	West Haven	8234	6649	1585	.1925	2.4
New Haven	"	East Haven	5619	2203	3416	.6080	6.0
Meriden	"	Yalesville	13,768	3002	10,766	.7810	3.0
Hartford	"	Rocky Hill	7558	6567	991	.1300	9.0
Union City	"	Waterbury	23,124	3107	20,017	.8657	4.0
Naugatuck	"	Waterbury	48,672	6051	42,621	.8757	5.0
New Haven	"	Woodmont	8580	3275	5305	.6183	6.4
Bridgeport	"	Southport	20,748	15,617	5131	.2473	6.6
Meriden	"	Wallingford	34,237	24,548	9689	.2830	6.0
So. Norwalk	"	Rowayton	33,606	21,814	11,792	.3509	2.1
So. Norwalk	"	Winnipauk	808	102	706	.8738	3.2
Derby	"	Ansonia	2479	2225	254	.1025	1.9
Birmingham	"	Ansonia	12,020	10,400	1620	.1348	1.9
		Total,	243,000	112,628	130,372	.5365	

Between Bridgeport and Fairfield (5.1 miles), for December, January, and February of the 2 years, the following figures were also supplied :

	1894.	1895.	Decrease.	Per cent.
December	5224	3598	1626	.3113
January	4601	977	3624	.7877
February	3940	903	3037	.7709
Total	13,765	5478	8287	.6005

Between Danbury and Bethel (3 miles) the following were the returns for 2 months :

	1894.	1895.	Decrease.	Per cent.
January	4698	2906	1792	.3814
February	7251	1401	5850	.8067
Total	11,949	4307	7642	.6400

The whole number of passengers for the stated periods of 1894 in the foregoing tables was 268,714 on about 55 miles (allowing for duplications) of the Consolidated road, and the decrease due to about the same total distance of trolley parallels was 146,301, or a little more than 54 per cent. Carrying out the ratios so as to obtain a full year's computation, the loss of the Consolidated Company would be represented by 339,744 passengers. The figures look large, but are not so impressive when reduced to dollars in the table following, where the liberal estimate is made of 2¼ cents loss per passenger per mile:

			Loss for the year.
Bridgeport	and	Stratford	$2,373
New Haven	"	West Haven	171
New Haven	"	East Haven	922
Meriden	"	Yalesville	1,453
Hartford	"	Rocky Hill	401
Union City	"	Waterbury	3,603
Naugatuck	"	Waterbury	9,589
New Haven	"	Woodmont	1,527
Bridgeport	"	Southport	1,523
Meriden	"	Wallingford	2,616
So. Norwalk	"	Rowayton	1,114
So. Norwalk	"	Winnipauk	101
Derby	"	Ansonia	23
Birmingham	"	Ansonia	148
Bridgeport	"	Fairfield	3,803
Danbury	"	Bethel	3,094
		Total	$32,461

The loss of $32,461 is partly offset by the economies of steam service represented by the withdrawal of one train between Waterbury and Naugatuck, and probably much further by additional business fed the steam road by lateral trolleys; and even the parallels must also have contributed something to general business to partly offset their competition. But, taking the sum as it stands, it represents but about ⅛ per cent. of the gross receipts ($25,576,884) of the Consolidated Company's whole system in four States. At the same time it is to be remembered that the loss by immediate competition tends to increase, and that Connecticut losses of the Consolidated Company represent but a part of the total which has its larger fractions in Massachusetts and suburban New York. In closing this statistical branch of the subject, it may be noted that operated trolleys now paralleling steam roads in the State represent a total of about 91 miles. Their effect as rivals is naturally much less marked in cases where old roads have been equipped with electricity than in those where new roads have been built.

The possibilities of electric rivalry with steam roads in the State open a wide realm for prophecy and speculation. The Consolidated corporation's managers undoubtedly dread less the merely local competition than the future welding of links of electric parallels into a single long parallel with threatened rivalry on distant business, especially in freights. The most sagacious opinion inclines to the belief that the immediate competition between proximate stations will hardly grow into serious rivalry between intermediate ones, and that the trolley as a parallel and competitor will presently be succeeded and offset by the trolley as a lateral and feeder.

Since the opening of the present year the story of the campaign of

steam against the trolley has been both in the courts and the legislature a well-nigh unbroken set of reverses for the electric companies. In the superior court, on the 10th of last April, Judge Hall made a most important ruling on the application of the New Britain Central Railroad and Electric Company to build a trolley line between that city (of about 22,000 inhabitants) and Hartford, some 9 miles distant. The case fell under the provision of the General Electric railroad law, which forbids a line parallel to a steam road unless the projectors shall have satisfied a superior court judge of its public necessity and convenience. In this case there can be no doubt that the new line would have been well patronized, though it paralleled pretty closely the New England and the Consolidated, which run many trains between New Britain and Hartford. Yet Judge Hall found against it on the question of fact, holding, apparently, that the rule of public convenience and necessity applied with equal force whether a trolley company owns its roadbed or is laid upon a highway, and that upon the street railway rests the burden of proof. As the steam companies claim unlimited power to multiply trains, especially if equipped hereafter with trolleys, this burden of proof may prove an obstinate barrier to parallel trolley enterprises, if Judge Hall's opinion prevails.

But it has been in the present legislature that electricity has met its most serious defeats. Under adverse committee reports parallel after parallel has been thrown out, including a projected line from Newington to Hartford, an extension of the West Shore road to Milford, and two projected parallels of the Derby division of the Consolidated road from Derby to New Haven. In two of these cases the deadly decision was made by the railroad committee that electric companies intending to own their roadbed must come in under the general steam railroad statute passed 20 years ago, and expressly intended by the Consolidated Company to impede steam parallel schemes. Its provisions are very severe, compelling, for example, large subscriptions per mile and prepayments before construction can be begun; and all the costly obstructions to a steam enterprise were thus made, by the committee's ruling, to apply to an electric road. The decision is absolutely technical, turning upon the point that the general electric law refers in terms to "street" railways; hence, as an electric company owning its roadbed is not a street railroad, it falls under the general steam-railroad law. While the committee's ruling follows the strict letter of the statute, it breaks its spirit, and its undue severity is manifest. Under it an electric company in Connecticut must confront the popular feeling against occupancy of rural highways on the one hand, and, on the other, the impeding clauses of the general steam railroad law. In consequence, during the last few weeks of the legislative ses-

sion, projectors of many trolley lines have had to be suppliants at the feet of the steam companies.

The many and long hearings in committee on the trolley schemes, while abounding in rhetoric and repartee, have contributed but little to the sober analysis of the subject. Counsel for the steam companies have appealed for protection of them as "children of Connecticut," as trustees of conservative and old vested interests, as large taxpayers, and as purveyors of safe, quick, and cheap service; while their opponents have urged with more force than effect the benefits and rights of new invention. This branch of the subject may be dismissed as falling into the limbo of commercial partisanship, save a reference to the claim of the steam companies that the trolley, being but "steam power applied at a distance," falls under the same rule of law as the more direct application of steam in the locomotive.

Intelligent public opinion in Connecticut, as distinguished from partisan opinion on the one hand and mere ignorance on the other, has passed through two stages, and is now in a third. At first it was distinctly hostile to the trolley during the period when electric transit was in its first ventures, when its equipment was bad, and when the noisy roads were deemed by many a crying nuisance. Later, as the system developed, public sentiment in both city and country became much more hospitable, and it was during this epoch that many streets and highways were rashly surrendered and valuable franchises granted without returns and with very inadequate restrictions or none. Since then there has been another reaction against the trolley, but along more rational and moderate lines. Popular judgment evidently favors now higher taxation of the trolley companies, the jealous preservation of the country highways both for present needs and future improvement, making the trolley companies pay for occupancy of city streets, and sharp checks on speculative financiering of trolley schemes. On the other hand, the plea of the steam companies that as vested interests they are entitled *ipso facto* to a cover against new invention on new application of old motive force finds scant favor, the recognized limitation here being that, where money seeks investment in a *bona fide* trolley enterprise, the test is a fair one of public necessity, whatever the steam companies may allege. As against the old vested funds, the rule holds clearly that electricity, paying fairly for its privileges, excluded from the public highways in rural districts and buying its own right of way, has a right to work out its own future, whether as a "parallel" or not. In that direction, at least, public opinion in Connecticut now strongly tends, and later is likely to crystallize, though perhaps not before steam and the trolley have brought many new and bitter conflicts.

UNINHABITABLE HOUSES IN CITY SLUMS.*

By William Stevenson.

THIS subject of unhealthy houses has been recently discussed by two very eminent and learned gentlemen, each on different occasions and in different towns. At the Sanitary Congress held in Glasgow, Dr. Russell, medical officer of health for Glasgow, read a paper on "Uninhabitable Houses: who inhabit them? who own them? and what is to be done with them?" In that paper Dr. Russell laid the blame for unhealthy houses on the immoral compact entered into between the tenant and the landlord, declaring that this compact was leading landlords, factors, trustees, beneficiaries, bondholders, and tenants down the broad road to perdition. On a more recent occasion, at Birmingham, this same question was made part of the groundwork and foundation of a great political speech by Mr. Chamberlain. He implied that houses became unhealthy because every man was not his own landlord. His words were: "I want to deal with the individual home. What is the best security and guarantee that the home of the workingman shall be comfortable and shall be healthy? It is that a man shall be the owner of his own dwelling."

I have read the statements of both of these gentlemen as they appeared in the newspapers, but I have failed to find that either of them has studied the question to its foundation or traced the disease to the first cause, and thus neither has been able to put forward a satisfactory specific for remedying the evil complained of.

Every man his own landlord and the owner of his own home is not a new cry and watchword, but a very old one indeed, dating back for the last 45 years to my own personal knowledge. It is an old story, and one which has been fostered and nursed by all kinds of building associations, loan societies, and companies of a kindred kind. Edinburgh and Leith, where these societies have been sown broadcast, are peculiarly applicable as evidence of the success or non-success of the proposal "that the best security and guarantee that the home of the workingman shall be comfortable, and shall be healthy, is that every man shall be owner of his own dwelling." I question if any two towns can be found in the kingdom where, from the house of the ordinary workingman and artisan, up through the middle to the more wealthy classes, so large a proportion of houses is owned, and has been

* A lecture recently delivered by Mr. William Stevenson, house factor, Leith, before the Unionist Club, London.

owned and occupied, by their owners. The owning and occupying by their owners of single houses in Edinburgh and Leith is not a thing of yesterday, but of generations back.

Within the last 20 or 30 years whole streets of new houses have been built in new and in suburban localities, suitable for occupation by the artisan, and by others higher in the social scale, and have been sold, to be so owned and so occupied by their owners. Houses of a less pretentious and imposing kind than the ordinary tenement have also been put up by building companies and by other builders, and with plots of ground, and have been disposed of to be occupied by their owners. The advertising pages of the newspapers afford indisputable evidence of the extent to which individual ownership of single houses prevails. The newspaper columns are filled with flats, half-flats, and single houses for sale; but full and complete tenements, put into the market, are comparatively few indeed. It may be true—at least it cannot be gainsaid—that all these houses, when first built, were considered of the most perfect construction, and were supplied with the most modern sanitary appliances of the times. But do we find on inquiry and investigation that all these houses, which were bought by their owners for their own homes, are still in a healthy, sanitary, and comfortable state, according to present-day requirements? Are one-fourth of the houses built within the last fifteen or twenty years now in such a condition of repair and of sanitary convenience as will fully meet the requirements of tenants, and stand modern scientific tests and requirements? If I am right in my conclusions and in the statements which I put before you, then the proposition "that every man, the owner of his own home, makes healthy and comfortable houses" is a fallacy and a delusion, and will not bear investigation. This fact leads me to consider and inquire how it comes about that the houses which have been built, even at a very recent date, and which, when built, were constructed on the most approved plan and fitted with sanitary appliances and other modern conveniences of the then most perfect kind, should in a very few short years become, so to speak, unhealthy. In house property we have a commodity of human construction, capable of almost indefinite increase, but a commodity subject, immediately on completion, to decay and deterioration, and from the very first requiring constant care and attention to keep it in repair and order. If we exclude premises owned and held for manufacturing and mercantile purposes, and confine our inquiries specially to house property, I think it will be found that comparatively little is held in ownership by the upper or wealthy classes, but that it is held by the lower or less wealthy classes, not for speculation, but as a sure and safe investment, and held by persons who have acquired the

means they are possessed of by care and frugality, and who have invested the whole, or nearly so, of their means in property as a competency for old age for themselves and wives, and with the expected reversion to their families or relatives after their death. In the investing of their carefully-gathered means little account has been taken of, and no provision has been made for, the continual outlay required for the repairs and upkeep which is necessary on house property. If money has been borrowed on bond or mortgage, as is often the case, the strain on the resources of the holding to make all ends meet is excessive. Every penny possible requires to be exacted from the rents by the owner or the life-renter. Not more than what is absolutely compulsory is expended either on repairs or improvements. The better class of tenants gradually remove to houses of more recent construction, and where they find the more modern appliances and conveniences. The houses have to be let to a class of more undesirable tenants, and gradually the property gets into disrepair, and from bad to worse goes down the hill, till ultimately, when it reaches the beneficiary, it is scarcely worth having.

In the case of tenements or other blocks of building owned by a separate individual for every separate house, and having many rights in common, repairs cannot be easily executed, except under compulsion of the authorities, and then only of the barest needs, and at a cost out of all proportion to the amount of work done. All this, perhaps, from the want of means by some, or want of inclination by others, of the common owners. If one owner desires improvement of his holding or the introduction of some more modern convenience or sanitary appliance, he is handicapped in his attempt to effect it, except at an inconvenience and cost disproportionate to the value of the alteration wanted. There is little or no control over the introduction of undesirable neighbors, and by the introduction of such persons the neighborhood becomes deteriorated. The dissatisfied leave the place, and either sell their house at a loss or let it at what rent can be got and to such tenants as they can command. And so this neighborhood also gradually goes down the hill and becomes an undesirable locality. Owners of single houses and property in common are handicapped at every corner against keeping their holdings in a good and healthy condition and repair by the disregard, carelessness, or impecuniosity of their neighboring owners. Many owners of their own houses, who are sensible of the insanitary and uncomfortable condition of their dwellings, continue from year to year to occupy them, well knowing and hiding their defects because of inability to meet the outlay, or perhaps a want of desire to effect the improvement; and it is only after the property is put into the market that the defects are found out.

In all large trading or manufacturing concerns managed on true business principles a certain portion of the profits are yearly set aside to meet depreciation, and for repairs and renewals. This is specially the case with our most successful shipping companies. I have never yet found any such thing as a reserve fund of this kind with individual owners of house property. Herein lies a pertinent cause of uninhabitable and insanitary dwellings. I have pointed out how liable house property is to decay and to deterioration. But hitherto it has been held as if it were an investment practically incapable of decay or deterioration, and as if, after having been once built, it were incapable of improvement, and had no necessity for any reserve funds for effecting these objects,—in short, held on rule of thumb, and on no business or commercial principle whatever, no provision or calculation being made for decay. Building and other loan societies, and the easy facilities with which loans can be got on mortgage over house property, are much to blame for bringing into the field of ownership large numbers of impecunious persons, who have not the wherewithal to hold on business and commercial principles the property they have acquired, and to maintain it in that state of repair and health which is required, even when they have the desire and knowledge to do so. Many persons become owners of their own houses and of property, who have never counted the cost on any sound business system.

There are most certainly—and it would be a pity if it were not so—very many individual owners of house property who hold their property as an investment, and who, during their own lifetime and with their own sanction, have the greatest care and concern that their properties should be always kept in the highest and most perfect state of substantial repair. But the life of every person is an uncertain commodity, and, when that passes away, then come other rules and other modes of management.

The leaving of property in life-rent has hitherto been a fruitful cause of rapidly leading property to decay and ruin. A life-renter has no interest in many cases in maintaining the property in any better repair than is sufficient to take as much out of the holding as possible. Needful repairs are executed with a grudge. Any substantial improvement which would retain a good class of tenants is absolutely refused. One by one the good tenants remove, and their place is bit by bit refilled by a lower and still lower class of tenants. The property itself not only goes to decay, but the neighborhood and neighboring properties become deteriorated past recovery at the same time.

The carelessness and indifference of tenants, and not infrequently wilful destruction by them of property, is becoming more and more every year a burning question, and one which will in the near future

have to be sternly faced. The destruction from carelessness and indifference is not confined to the lower class of tenants, but is a cause of complaint against many of the would-be upper class, and whose standing and position lead to an expectation of better things.

Neighboring owners, I have said, and as I have good reason to know, are often the cause of the deterioration of a neighborhood. Thoughtless and regardless modes of management lead to serious loss to other owners who have the best intentions.

Trustees holding for beneficiaries and heritable creditors in possession have hitherto been seriously handicapped in keeping and maintaining property in a good and lettable condition, and abreast of modern improved requirements. They had power only to do necessary repairs. When mortgages had been foreclosed, it was a certainty that the free income from property had been insufficient to meet the interest. In such cases it was almost hopeless to expect improvements or any repairs beyond those allowed by law. The buildings may have been good and substantial so far, but by the inability of the holders to introduce from time to time better and more modern conveniences it is found impossible to retain the best class of tenants. They migrate to where these modern conveniences are found. The heritable securities act, just become law, will substantially improve the position of heritable creditors in possession.

The jerry-builder is the back on which is most often laid the blame for unhealthy and insanitary houses. The speculative builder is not an article of self-creation. He was brought into existence to meet the demand for a cheap and flimsy article. He is not to be blamed for providing the article wanted by impecunious buyers, greedy of big interest and big bargains, and who have neither the knowledge or the desire to appreciate a good and substantial article,—the best value in the end. He is the counterpart of the Cheap Jack, and owners of the slop-shops on the bridges and elsewhere, who supply the demands for the cheapest clothing and other articles. Even Mr. Chamberlain in his speech at Birmingham stated that he had been in search of a Cheap Jack, and had found one who could supply the very best article in the market in the way of healthy houses for workingmen at £140 each.

In the preceding remarks, if you will allow me shortly to recapitulate, I have pointed out that the owning of their own homes by the occupiers has not been successful in making healthy and comfortable houses, but, on the contrary, has specially contributed in Edinburgh and Leith in making houses unhealthy and insanitary. I have pointed out that the system of leaving property on life-rent is another of the causes which contributes to the same end. I have shown that the

holding of property by bondholders and by trustees assisted to the same end. I have also shown that even the individual owner of property having the best intentions, and because of neighboring owners and the uncertainty of his own existence, and because of the inability to control what may come after him, is unable to prevent the very best class of property from becoming unhealthy, and I pointed out that a serious factor in the question is the universal want of any reserve fund on which to rely for effecting repairs and renewals. These and the want of a perpetual and continuous system of management, continuing from year to year in perpetuity and without a break, all lead to the same end. Experience has thus taught us in the past, and the reports of medical officers of health and sanitary inspectors tell us in the present, that individual ownership of house property has been unable and unsuccessful in its management in preventing property from becoming the slums and the rookeries of our towns.

I now come to the second part of my story, and the more pertinent point,—the remedy which I would apply. If my indictment against the holding of property privately or by individual owners is found to be relevant, and if the proof which I have set before you brings in a true bill, as I hold it does, then I submit that all individual and private ownership in house property in towns should cease and terminate. I make the recommendation advisedly, unreservedly, and in its broadest sense to all house property having common rights. In the owning of property for letting purposes I would exclude the State; I would exclude municipal authorities and every other elected body elected by the ratepayers for administrative purposes only. The constitution of all such bodies unfits them for the management of commercial and mercantile undertakings.

I would like to see, and I recommend, that the owning of house property be taken up by joint-stock companies, or such like corporations, or by some kind of syndicate, and which might be limited and might be coöperative. In the formation of such companies and corporations there could be no risk if judiciously gone about. The property would be managed from year to year on uniform and business principles, and with perpetual succession in the management,—uniform and continuous; not erratic, spasmodic, and uncertain. The dividends would be paid half-year and half-year, uniform and of known quantity, with sufficient reserve for all emergencies or improvements and for renewals. I see no reason why workingmen of all classes should not join in and invest their frugal savings in such a manner from the single £1 and upwards. Such investments would not be speculative,—expected to yield from 6 to 10 per cent.,—but I see no reason why a uniform and constant dividend of 4 to 4½ per cent. should

not be made. In such companies owning whole and undivided blocks of houses, and having no mutual obligations, improvements in internal arrangements and fittings, and the introduction from time to time of the most modern and approved sanitary appliances, could be effected with perfect facility and freedom, as it was found that such became necessary and advantageous for maintaining the houses in the best and most forward condition ; by always keeping the houses in such forward condition, retaining and keeping the best class of tenants, the locality also would be maintained in a high-class position. In such companies or corporations shareholders and members could with every confidence bequeath the life rent to one person and the fee in reversion to others, knowing that the life-renter would have no control in deteriorating the principal, and that the fee would go down to the reversionaries unimpaired, and in the same substantial condition in which it was left at the date of bequest.

The model after which I suggest construction is the insurance companies and the Scottish bank. Intelligent and energetic artisans would be of the utmost use in the management. Their training in various trades connected with property would make them so. And if we are to believe in the success of the coöperative enterprise and benefit societies, it is manifest that they have business capacity.

I have been unable to find out the existence of any kind of company or association in Scotland of the nature or constitution I recommend, except one in Glasgow,—The Glasgow Workman's Dwellings Company, Limited. It has been in existence for a short time only, and on June 30 last they issued their first full year's statement of accounts. Through the courtesy of their secretary I have been furnished with a copy of that report and with other documents relating to the company. The paid-up capital is nearly £15,000. After paying all expenses for the year,—one-third of the preliminary expenses in forming the company,—a dividend of 3½ per cent. was paid. £198 was placed to a reserve fund, and £36 was carried forward to next year. The company's operations consist chiefly in buying up old and insanitary property, and, after putting it into a perfect state, letting it out. The rents are all weekly, and from 2*s.* to 3*s.* This company is perhaps of a semi-charitable nature, but it is substantial proof of what can be done with even the lowest class of property, and with the poorest but decent laboring classes. It is providing them with good and healthy houses, and it is paying the shareholders of the company an honest dividend.

IMPROVEMENT OF THE DELAWARE RIVER AND THE HARBOR OF PHILADELPHIA.

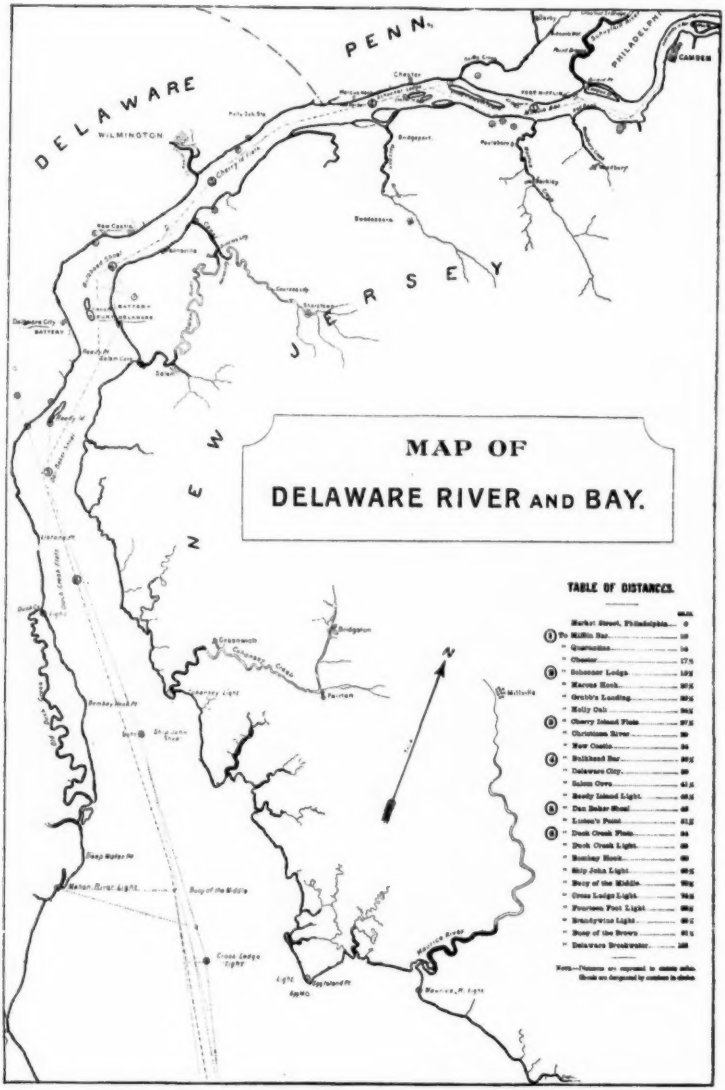
By John Birkinbine.

THERE is now in progress an improvement of the Delaware river believed to be the most pretentious attempt yet made to regulate a tidal stream and maintain the channel mainly by tidal influences; and the work of rectifying the harbor of Philadelphia has caused the assemblage of a fleet of dredges which has probably never been exceeded in capacity.

The portion of the Delaware river affected by tides embraces a distance of 135 statute miles from Trenton, N. J., the head of navigation, to the Delaware breakwater at Cape Henlopen, its eastern shore being in New Jersey, while of the western shore 63 miles are in Pennsylvania and 72 miles in Delaware, half of the latter bounding Delaware bay (see map 1).

From the Delaware breakwater at Cape Henlopen to the commercial portion of Philadelphia—a distance of 100 miles—vessels drawing 20 ft. now pass at any stage of the tide, which has a rise of 4 ft. 5 in. at the Capes, 6 ft. at Philadelphia, and 4 ft. 1 in. at Trenton. The removal of six shoals which obstruct 16 miles of the river channel at the points indicated on map 1, and the widening of the channel, will give a draft of 26 ft. at low tide in a channel remarkably direct and 600 ft. wide, as a minimum, between the ocean and Philadelphia.

Up to about 1870 the river channel over the different shoals below Philadelphia had considerably less water than now, for the draft has been increased by dredging and by dykes, so as to admit of the passage of large vessels at high water. The augmented size and draft of vessels, however, make imperative the further improvement of the river, so that the port of Philadelphia shall be no less accessible to foreign trade than the ports of New York, Boston, and Baltimore. But the biannual appropriations as made available by the general government would postpone the completion of the work too long, and Philadelphia has supplemented the government allowance for improving the Delaware river below the city. Similar assistance has already been given by the municipality and commonwealth for the improvement of the harbor of Philadelphia; for, as the Delaware river is well lighted and buoyed, the commercial advantages which would follow improved facilities for water transportation would only be obtained by perfecting the harbor of Philadelphia, so as to invite the largest shipping to use it



MAP OF DELAWARE RIVER AND BAY.

TABLE OF DISTANCES.

		Miles.
	Market Street, Philadelphia	0
(1)	To Billiu Bar	10
	" Quarantine	14
	" Chester	17½
(2)	" Delaware Lodge	19½
	" Marcus Hook	20½
	" Orvin's Landing	26½
	" Holly Oak	28½
(3)	" Cherry Island Flats	37½
	" Christiana River	39
	" New Castle	34
(4)	" Bulkhead Bar	39½
	" Delaware City	39
	" Salem Cove	41½
	" Reedy Island Light	48½
(5)	" Pea Baker Shoal	49
	" Liston's Point	51½
(6)	" Duck Creek Flats	54
	" Duck Creek Light	59
	" Bombay Hook	60
	" Ship John Light	69½
	" Buoy of the Middle	70½
	" Cross Ledge Light	74½
	" Fourteen Feet Light	80½
	" Brandywine Light	89½
	" Buoy of the Brown	91½
	" Delaware Breakwater	100

Note.—Distances are expressed in statute miles. Shoals are designated by numbers in circles.

liberally. The amount of money represented in a modern vessel is too great to permit of the delays involved in waiting for favorable conditions of tide in order to pass shoals.

From Trenton to near Bordentown, N. J. (5 miles), the river is from 800 to 2000 ft. wide, the channel being available for small craft only. From Bordentown (where the Delaware and Raritan canal connects the Delaware river with the harbor of New York) to the upper boundary of Philadelphia (18 miles) the river varies from 800 to 3400 ft. in width.

Opposite Philadelphia is Camden, N. J., and between these two cities there were three islands, which were considered as seriously influencing the tidal currents, the river being broadened at one point to 6000 ft. The rectification of the harbor of Philadelphia required the entire removal of two islands, the partial removal of the third opposite large coal shipping docks and Cramps' ship-building works, and the advance of the pier-head lines along the river fronts of both Philadelphia and Camden.

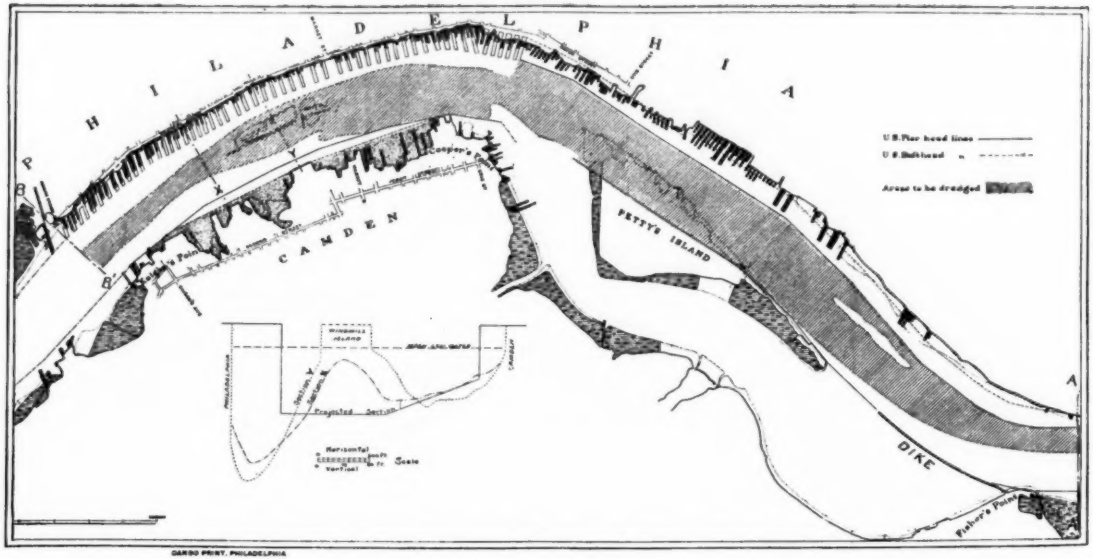
South of the sites of these islands the river broadens, and 6 miles below, on League Island at the mouth of the Schuylkill river, but within the limits of Philadelphia, is the United States navy yard.

Continuing below Philadelphia, the river proper, constantly widening, extends to Delaware bay, which has a maximum width of 27 miles, but is contracted at its entrance to 11½ miles between Capes May and Henlopen. The gradual widening of the river as it approaches the sea is advantageous for the admission and to promote the regular flow of the tides, the retardation of the tidal waves being such that, when it is high water at the breakwater (where Delaware bay debouches into the ocean), it is low water at the northern boundary of Philadelphia. The descent of the river bottom from Philadelphia to the sea is between 2 and 3 ft.; therefore, when the tide is commencing to ebb at Philadelphia, a vessel entering the capes is floating on water several feet higher than the water at Philadelphia, and, if this vessel travelled at the rate of from 16 to 19 miles per hour, it would come all the way up to the city with the tide at flood level. The flood tide lasts about 5, and the ebb tide 7½, hours at Philadelphia.

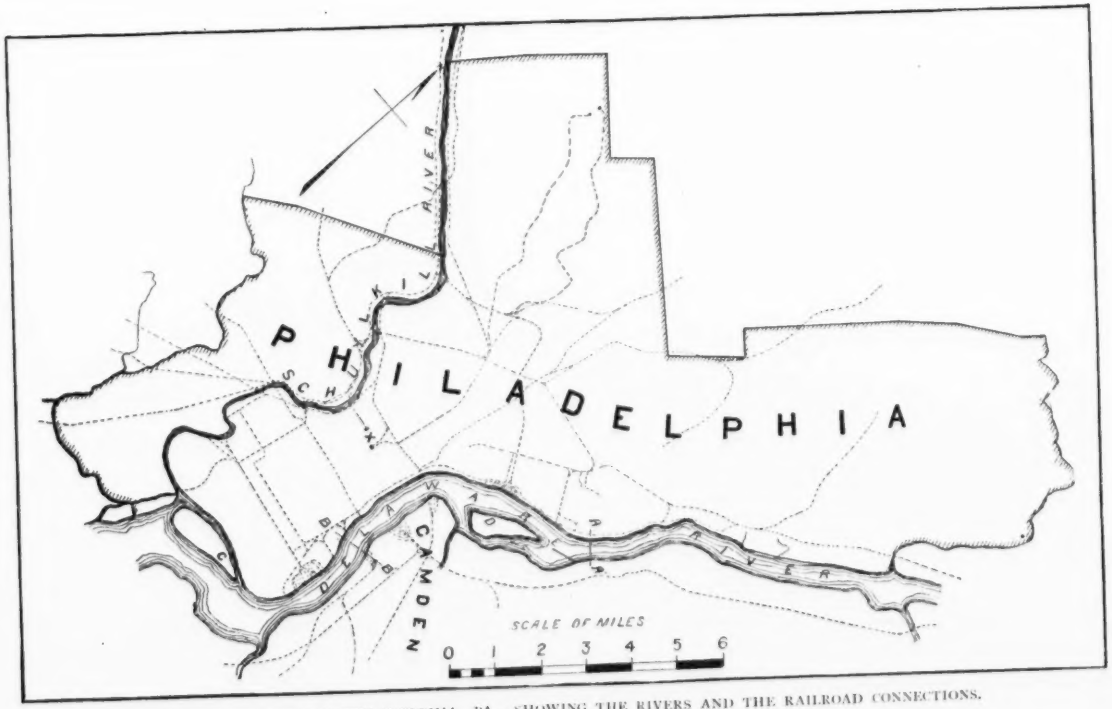
Major C. W. Raymond of the Engineer Corps, U. S. A., in charge of the work on the Delaware river, asserts that wave action as affecting the channel ceases 50 miles from the ocean, and he considers that between Philadelphia and the limit of wave action the channel is acted upon by the tidal forces only, this portion of the river being designated "The estuary of the Delaware."

According to Mr. L. Y. Schermerhorn,* gagings indicate that

* Proceedings of the Engineers' Club of Philadelphia, Vol. XI.



SKETCH OF THE PORTION OF PHILADELPHIA HARBOR UNDER CONTRACT FOR RECTIFICATION.



MAP OF THE CITY OF PHILADELPHIA, PA., SHOWING THE RIVERS AND THE RAILROAD CONNECTIONS.

2,000,000,000 cu. ft. of water pass through the harbor of Philadelphia with each ebb tide, and 1,860,000,000 cu. ft. with each flood tide,—a volume of 245,000,000 tons of water passing daily. Gagings of the river above tidal influences in months free from freshets indicate a flow of 3300 cu. ft. per second, or 285,000,000 cu. ft. per day.

This river has the peculiarity of showing close correspondence to an empirical formula for retardation as determined by the United States Coast Survey,—*viz.*,

$$\text{Flood, } y = 2.2\,x + 0.018\,x^2$$

$$\text{Ebb, } y^1 = 3.4\,x + 0.018\,x^2$$

in which y and y^1 are the retardation in minutes and x is the distance from the breakwater in nautical miles.

The improvement of the Delaware river may be considered under two general heads,—*viz.*, the estuary, and Philadelphia harbor.

Map 1 shows the general course and shore of the estuary of the Delaware from the upper portion of Philadelphia to the Atlantic ocean, the prominent towns and the location of existing channel obstructions also being indicated.

In the scheme for the improvement of the Delaware river devised by a board of the Engineers' Corps of the United States Army in 1885, a ship canal, having a least width of 600 ft. and a depth of 26 ft. at mean low water from Philadelphia to deep water in Delaware bay, is to be obtained by regulating the tidal flow by dikes, with recourse to dredging, where necessary, and as an aid to such contracting and regulating works. Major Raymond* says that the river above the estuary receives a considerable amount of material from above tide water, and deposits the greater—that is, the heavier—portion of it between the head of the tide and the lowest point to which one ebb current reaches. Below this reach, material held in suspension, whether from above tide water or scoured from the bed and banks, is carried down stream by each recurring ebb, until it reaches a point where the conditions are favorable for its deposit. The flood and ebb currents, following different paths, often run on opposite sides of the river, the space between them being a region of weak currents, where the conditions are favorable for the building up of a shoal; also, where the river runs in a wide natural depression in which it did not fully form its own bed, the water will spread out, and its velocity will be diminished, and material will be deposited until the cross section is reduced to its normal dimensions,—*i. e.*, the dimensions maintained by the tidal forces only. But in such material as compasses the bed of the Delaware river it is possible to maintain a channel of greater depth

*A lecture delivered at the United States Engineering School at Willet's Point.

than the unaided power of the river is able to create. As part of the channel between high and low water is exposed to the action of ice and storms and the encroachment of animals and man, the average width of the river is greater than the normal width, and the average depth less than the normal depth. The project submitted by the board of engineers in 1885 was simply to deepen and maintain the channel at six points of obstruction by building stone dikes from 5000 to 25,000 ft. in length, at or below the level of low water, generally on the west side of the channel. If these works did not produce the desired effects, dikes opposite them on the eastern bank of the river were to be constructed. Subsequent investigation indicated that in the Delaware river the dikes should be extended above high water, and this policy is now being carried out.

The position taken is that dikes improve a channel either by training the tidal currents so that they work together, and in the proper places, or they increase the intensity of the tidal action by confining the flow within narrower limits than those which it previously occupied, or in both these ways together.

In rivers where fresh water forms a large part of the volume passing through the channel, as is the case in most European rivers which have been improved, it may be desirable to place the dikes within the limits of the normal tidal width ; and, when this is done to increase the effect of the fresh water, the dikes must be kept at or below low water, in order to reduce the normal dimensions of the tidal prism. In a purely tidal river like the Delaware (that is, in one where the fresh-water discharge is so small—about 9 per cent.—that it may be neglected in comparison with the tidal volume) it is doubtful whether much permanent improvement can be obtained by low-water dikes.

The single dikes on the Delaware river, constructed in accordance with the adopted plan, have, as far as completed, indicated an ability to maintain, and in some instances to create and maintain, the channel depths ; and the increase in height which has carried most of these dikes 2 ft. above high tide has apparently borne out the above conclusions.

The removal of the six shoals in the Delaware river, while of technical interest and commercial importance, is less of a problem, financially considered, than the dredging of the bar of the Mersey river, which handicapped the trade of Liverpool ; and the cost of such removal will be but small when compared to the expenditures upon schemes of canalization which have been carried out to improve the facilities of Glasgow, Scotland, or Manchester, England.

The improvement of the portion of the Delaware river considered as the harbor of Philadelphia requires special treatment, including

dredging liberal amounts of material, removing islands and bars, and adapting the average cross section to what is considered as the normal area.

Map 3 shows the position of Philadelphia with its river frontage and its railroad facilities. The portion of the harbor now under contract for improvement is shaded, and embraced between the lines A A^1 and B B^1, the business center of the city being indicated by the mark X, which represents the location of the municipal building and the two great railroad passenger terminals. Areas which are being filled with a portion of the dredged material are shown at C and D. Congress has lately authorized the construction of a railroad drawbridge just above the northern terminus of the dredging now in progress; this bridge, upon which work is now being prosecuted, is near the line A-A^1. Objection to its construction is made on account of the bridge floor being but 50 ft. above high water. The water-front of Philadelphia extends 20 miles along the Delaware, 6 miles of which are covered by the improvement now under contract; and, in addition to the Delaware river frontage, there is the tidal portion of the Schuylkill river, which is navigable for vessels drawing 18 to 23 ft. for 7.3 miles,—wharves, manufacturing industries, grain elevators, oil-refining works, etc., lining both sides of the stream.

The work of rectifying the harbor of Philadelphia, as set forth in the specifications, contemplates the formation of a channel about 2000 ft. in width, with a cross section of 55,000 sq. ft. at mean tide for 6 miles along the Philadelphia shore (between points A and B), at a distance far enough from the present wharf-line to permit the extension of the wharves 500 to 600 ft., and the widening of the avenue at their shore ends; the removal of Windmill and Smith islands and the adjacent shoals, so as to form a 26-ft. channel about 1000 ft. wide along the front of the revised Philadelphia wharf-line; widening the Pennsylvania channel at Petty island to about 2000 ft. with a depth of 26 ft. over a width of about 1000 ft., the channel sloping to a depth of 12 ft. in the remaining width, and a resulting cross section of about 55,000 sq. ft. (see sections on map 2).

Smith and Windmill islands were situated about 800 ft. from the ends of the existing Philadelphia wharves, and about 1200 ft. from the ends of the Camden wharves. The area of Smith island—about 8 acres—was partly inclosed by a revetment of cribwork, piling, and wharves, generally backed with stones; and just north of it there was a cross channel revetted on both sides by pile dikes, filled with stone and gravel. Above it was a shoal extending about 1 mile toward Petty island, and having on it less than 6 ft. at mean low water.

The area of Windmill island was originally about 17 acres; a por-

tion of it was revetted with crib-work, piling, and wharves backed with stones. Below the island was a shoal, having on it an average depth of about 10 2-10 ft. at mean low water for a distance of about ¾ of a mile.

The surface of the islands averaged about 9 ft. above mean low water, and about 3 ft. above mean high water. From borings made in the Delaware river, it appears that rock was not encountered at a depth of less than 39 ft., and on the bar just above Smith island it was reached only at a depth of over 100 ft., and on the islands no rock was reached at a depth of 24 ft. below mean low water.

Petty island, situated 2 miles above the head of Smith island (the two being almost connected by shoals), was about 2 miles long, and had an area of about 360 acres. Its surface, being chiefly below the plane of high water, is protected from overflow by earthen dikes. The plan of improvement contemplates the removal of a part of the northern side of the island, some of the dredged material being employed to raise the surface of the remaining portion. The shore line is partially protected by wharves and timber revetment.

The work required the removal of all trees, structures, pile and timber wharfing or revetment from the islands, and the timber work of the dikes which form the cross channel; also the removal by dredging and by natural scour of the tidal currents of 21,500,000 cu. yds. of material, place measurement.

A part of the dredged material is deposited and spread on League island (at C, map 2) by hydraulic conveyors. It was estimated that 2,000,000 cu. yds., place measurement, would be required for filling the spaces designated; but the government reserved the right to require an additional amount of dredged material not exceeding 5,500,000 cu. yds., place measurement, to be deposited and spread within the limits of League island navy yard in locations to be indicated; all dredged material not otherwise provided for to be deposited behind the Mifflin bar dike, about 10 miles below Windmill island, and in the back channel of League island navy yard.

Dredging is paid for by the cubic yard as measured in scows, except when the material is placed on Petty island, in which case it is paid for by the cubic yard as measured in the dipper. All measurements are made at the place of deposit. The deposit and spreading at League island is paid for by the cubic yard as measured in place in the fill above the present surface of the ground, with no allowance for shrinkage or settlement.

Map 3 shows in detail the portion of the Delaware river now being improved, the shaded portion exhibiting the area to be dredged; it will be noted that this area covers Smith and Windmill islands, which

have been entirely removed, and a part of Petty island, which is being cut away. Original cross sections of the river at two points and the projected section as it will appear when the work is completed are also indicated. The present wharves are shown in full, and their extension in outline for a portion of the Philadelphia water-front.

The narrowing of the channel is secured by a material advance of the pier head lines on both Philadelphia and Camden water-fronts, to secure a cross section approximating what is estimated by the United States Engineer Corps to be the normal channel section.

The record of the improvement of Philadelphia harbor properly commences in 1888 with a resolution of congress providing for a commission of three engineers to examine and report in relation to the Delaware river between Philadelphia and Camden, and authorized to establish harbor lines. The board now consists of Col. Craighill, Lieut. Col. Comstock, and Maj. Raymond, the latter the engineer in charge. In April, 1891, a contract was entered into; but before the close of 1892 this contract was annulled, because of "failure to prosecute the work faithfully and diligently." After readvertising, a contract was entered into on June 1, 1892, with the American Dredging Company, at the following prices: 14.2 cents per cubic yard for excavating and depositing material at places approved by the engineer in charge; $1.90 per linear foot for removing pile and timber wharfing or revetment: and 16 cents per cubic yard additional for depositing and spreading material upon League island. The requirements were that 900,000 cu. yds. were to be removed during the first 3 months (July, August, and September, 1893), 350,000 cu. yds. being dredged each succeeding month, and that a total of 3,000,000 cu. yds. were to be removed by June 30, 1894, and 5,100,000 cu. yds. by December 31, 1894.

Work was properly commenced, and a fleet of tugs, dredges, and scows assembled. Up to the close of the fiscal year ending June 30, 1894, the record, according to the report of the chief of engineers, was as follows: Smith and Windmill islands were entirely removed to a level of not less than 12 ft. below mean low-water, and the northern side of Petty island was dredged back so as to give a minimum width of about 1400 ft. to the Pennsylvania channel. The total amount of work accomplished to June 30, 1894, was: material removed by dredging, scow measurement, 5,842,927 cu. yds.; piling and revetment removed, 22,664 linear ft.; dredged material deposited and spread on League island, scow measurement, 1,636,087 cu. yds. These amounts were in excess of the requirements of the specifications, but work was continued energetically until December 29, 1894, although the appropriation available had been exhausted; and, when operation

was suspended for the winter, the record showed: dredged material removed by scows, 7,675,230 cu. yds.; dredged material deposited upon Petty island, 739,553 cu. yds.; total, 8,414,783 cu. yds., removed in 20 months,—an excess under the present contract of 62 per cent. In addition 1,740,000 cu. yds. of this material was re-handled and deposited on League island, giving a place measurement of 1,139,000 cu. yds. An interesting feature of the work of the dredges is the apparent increase in volume of scow measurement over the quantity *in situ*, and the shrinkage and loss when redeposited. One thousand cu. yds. in place in the bed of the river measured in scows about 1250 cu. yds.; but, after the scows have been dumped, and the material sucked up by the pumps and carried onto League island, this original 1000 cu. yds. measures in place but 780 cu. yds.

The volume of water used to convey mud and gravel is eight to nine times that of the material carried, and the greatest distance to which this has been conveyed in the 30-in. conduit pipes connecting with League island is about ½ mile.

On both sides of the Delaware river there is land below high-water level which is protected by dikes, upon which the excellent filling material being dredged could be placed with advantage; but, owing to the failure of property-owners to recognize the present advantage, great quantities are being dumped in unused or shallow portions of the stream.

If to the quantity dredged up to December, 1894, is added the amount re-handled in filling League island, the total will be in excess of 10,000,000 cu. yds., scow measurement,—a quantity which would cover an area of 1 square mile about 10 ft. deep. This has been moved by an equipment of from 10 to 14 dipper and grapple dredges, three hydraulic dredges, 75 to 90 dump scows, holding an aggregate of 25,000 to 30,000 cu. yds., and 18 to 25 steam tugs; which, if placed in line, would make a procession 2½ miles long, representing an outlay of $1,250,000. The force of men required to operate and care for the equipment of dredges, tugs, and scows ranges from 300 to 400, in addition to about 100 more engaged in the shops and yards on construction and repair work. From 2000 to 2500 tons of coal are consumed monthly, when the dredges are at work.

In October, 1894, the equipment removed 745,000 cu. yds. by dredging, and deposited 187,000 cu. yds. of this upon League island,—a total for the month of 932,000 cu. yds., or an average of 34,500 cu. yds. handled per working day of 11 hours.

The character of the material excavated varies as widely as its location. In places it consists of nearly clean sand; at others, of soft clay and sand mixed in proportions varying from 25 to 75 per cent.

of either; at other points glacial drift is found composed of hard clay mixed with gravel and large boulders. For the sand, hard clay, gravel, and boulders only dipper dredges can be used with advantage, while in the softer material, consisting of mixed sand and soft clay, the grapple dredges are employed. The capacity of these dredges depends mainly upon the character of material to be excavated, varying from a maximum of 4000 cu. yds. per day in the softer material to 400 cu. yds. per day in the harder.

In disposing of the dredged material the scows are towed distances of from 20 to 35 miles on the round trip, depending upon the location of the dredges in relation to the dumping ground. The towing is done by large tugs hauling fleets of from four to fourteen scows at a time, moving with the tide up and down the river. Usually the tows leave at high water, moving down the stream on the ebb tide, and, after disposing of the contents of the scows, return with the following flood tide.

The estimated cost of the 21,500,000 cu. yds. of dredging required for the rectification of the harbor of Philadelphia is $3,500,000; the cost of removing the shoals below Philadelphia, as before stated, is $2,425,000, of which about $1,000,000 has been paid out; but to complete the harbor facilities Philadelphia will expend probably $8,000,000 in extending wharves to the new dock lines, with slips long and deep enough to accommodate the largest ocean vessels, and in widening Delaware avenue, which skirts the bulkhead line, so as to give ample room for wagon traffic, and also for the railroad tracks by which access will be given to all wharves under equal terms to all railroads entering the city.

When the harbor improvements are completed and the existing obstructions in the Delaware river below the city are removed, Philadelphia should be in position to compete with any other American city on the Atlantic coast for foreign trade, and be able to claim the advantage which its geographical position gives of shorter railroad haul to distributing points for the growing central and western States.

IS THE INVENTIVE FACULTY A MYTH?

By W. H. Smyth.

TO the ordinary mind a profound mystery appears to envelop the work of the inventor. He is looked upon with a species of awe, as one endowed by nature with what is known as the "inventive faculty"; a special organ or sense, having occult capabilities of inspiration and creation; a sort of automatic mental mechanism, needing only that its fortunate possessor should "touch the button" in order that, presto! the desired invention may instantaneously evolve from nothing. In fact, the great mass of even intelligent people of our age regard a noted inventor as nothing less—and nothing more—than a "wizard." As we go on, we shall see that this extraordinary delusion is shared, not only by the majority of inventors themselves, but in effect by the federal courts having jurisdiction in controversies relating to patents for inventions, as well as by the tribunals of the patent office.

The intimate relations which it has been my fortune to sustain with many different inventors through a long period, and my own experience in a capacity which may perhaps be regarded as that of a professional inventor, have led me to adopt certain views as to the nature and qualities of invention, and the mental processes of which the completed invention constitutes the tangible result, which in many respects are widely at variance with those which have heretofore found general acceptance. Whatever may be thought of the correctness of these views, it may at least be affirmed that, when formulated into a working hypothesis, they have enabled inventions to be conceived and worked out with no less certainty and accuracy of results than are common in other departments of science in which the phenomena and processes have been investigated, classified, and subjected to fixed laws. They have further led to the belief that not only is the popular conception of the mental operation of invention a wholly erroneous one, but that what is loosely termed the "faculty of invention" is one which is just as much capable of acquirement by proper instruction and cultivation as any other; in short, that, like carpentry or shoemaking, it is nothing more or less than an art.

If these conclusions be well-founded, it is at once apparent that they tend to bring within the scope of scientific methods one of the most important departments of human endeavor, and one which, even in its present chaotic condition, has perhaps been the most important of all agencies in the advancement of modern civilization.

I hold that that which is commonly termed the "inventive faculty" is nothing more than a combination of certain mental faculties with which every rational human being is endowed to a greater or less extent,—namely, vizualization, memory, and reason.

The mental process involved in making an invention is analogous to that employed by the child in building with his toy blocks. Conceiving the idea of building some sort of house, he first arranges those which he thinks most suitable for the foundation, and continues by selecting from his store of blocks of various shapes and sizes those which he finds best adapted to form the various parts of the complete structure he has in mind. So too the inventor selects from the store of elementary mechanical parts or combinations with which memory has furnished his mind those which he regards as available for his purpose. The child builds and rebuilds; he changes a block here, and removes or adds a block there; so does the inventor, although in his case the mental operations of selection and arrangement are often so quickly and so automatically performed as to escape even his own observation. The material, too, with which the inventor works is infinitely better adapted to its purpose than are the blocks of the child with their unchangeable shapes and dimensions. It may be hard or soft, hot or cold, pervious or impervious, transparent or opaque, elastic or rigid, fluid or viscous; in short, it may be regarded as infinitely plastic, though possessing every other inherent quality known in nature or art.

When confronted with a defect in his structure, the child is compelled to laboriously select from his heap of blocks, critically examining each one and trying its effect as a part of the whole; but the inventor's mass of material is of a much more manageable character. In an instant the panorama of memory is unfolded, and he makes his selection,—a process which may be repeated not merely once, but a hundred times, while the hand of the child would be faltering over a single block. Among this material the mind of the inventor works as a modeller in infinitely plastic clay. With such facilities and such material why should not great results be accomplished? On the contrary, would not he be a bungler indeed who under these conditions should prove to be incapable of producing a worthy result?

Why, then, do we find the patent office at Washington to be a vast storehouse, filled with every conceivable form of foolish, silly, illogical, and useless contrivance? Why this immeasurable waste of money, time, and effort in the production of useless rubbish? Why is it that the very name of "inventor" has become a synonym for an irrational and crack-brained enthusiast, and a title which the originator of an important or valuable device no longer cares to accept? The reason for this state of affairs is not far to seek.

Let us again revert to our illustration of the building-block, and add to the other conditions under which the child is compelled to work one more which is necessary to complete the analogy. Let us assume the blocks to represent, not only the actual things from which the inventor's conceptions have been derived, but his mental conception of those things. A very strange state of affairs now arises, which is due to the difference between the concept and the reality. It is as if, the instant a block were picked up for use, it should, wholly unperceived by the child, assume a distorted shape,—the cube, for example, being no longer cubical, or the cylinder no longer cylindrical. The extent of the distortion, being a variable quantity, may range from an almost immaterial difference to the assumption by the cube and cylinder of the characteristics of each other, to say nothing of infinite possibilities of error in all other directions. Such an imagined distortion of the shape of the blocks is more than paralleled in the distorted mental impressions of exterior objects existing in the mind of the ordinary untrained observer; in fact, it is only the few who observe with even approximate accuracy, and still fewer who have the capacity to retain a correct mental impression of that which they have observed. Let the ordinary person attempt to make a drawing of, say, a round-topped table. After a careful examination, he will probably proceed to draw, to the best of his limited ability, a circle, and next, with more or less accuracy, the legs, ending upon a horizontal line intended to represent the floor. Now mark! the circle has been drawn, not because the impression of a circle has been made upon the retina of the draftsman, and so on his mind, but because he knows, or thinks he knows, that the top is circular. The fact that the legs rest upon the horizontal floor is quite sufficient to justify the delineator in his belief that he sees that which is not to be seen, and he represents it accordingly.

Think of a man, no matter how quick in perception or how logical in mind, but with his memory stocked with erroneous conceptions like these, often not even rising to the dignity of caricatures of the external objects which they are assumed to represent! From such a mass of mental material is it conceivable that it would be possible to produce anything whatever which, when completed, should bear any logical relation to real things? Most certainly not; such a production could only find its fit place among the aggregation of abortive refuse which already encumbers the cabinets of the patent office.

The field of invention extends far beyond the narrow limits which custom has assigned to it; ingenuity and invention may be and are manifested, not alone in the works of the mechanician, but in those of the musician, the poet, the author, the lawyer, the physician, or the theologian. But, alike in the case of these and all other

inventors, a certain mental equipment is an indispensable requisite to success. There must exist, first, an unerring and accurate perception of those similarities and differences which are fundamental in their nature; second, the capacity to distinguish the pertinent from the fortuitous in the particular problem under consideration; and, third (and this applies particularly to the mechanical inventor), the ability to clearly visualize, so that he may examine his structure as it progresses, and may select and, if need be, adapt, the elements he selects from his store, to the end that they may be coördinated with that structure.

The process of mind which I have termed "visualization" is curiously exemplified in an incident which I will give as nearly as possible in the language of the narrator:

"I have on several occasions surprised myself, so to speak, in the act of going through a mental operation which, for want of a better name, I will call 'manualization,'—that is, using mental hands to manipulate mental material. This has only occurred, so far as I can recall, on occasions when I have been struggling mentally with some aggravatingly refractory problem of mechanical detail, which, though really no more than a pretty little puzzle, has concentrated my attention until the entire mental effort was focused on the rebellious point in strained and intense abstraction, the incomplete portion being in clear and sharp visualization. Then, slowly and as if with great effort, two hands would be laboriously pushed into view, and would take hold of the unfinished part and twist and shape it until it assumed a form adapted to the desired end. Then, like a flash, the strain would relax, the apparition vanish, and I would perceive myself to be a relieved, but exceedingly tired, individual. The visualization, including the hands, would still remain in mental view for possibly a second or two after the completion of the work."

If it were true that the so-called "faculty of invention" is something unique and apart from other forms of mental activity, it would certainly seem as if its manifestations must be so characteristic as to be at once recognizable. Such, however, is by no means the case. Is it not a most suggestive fact that, while the question of the presence or absence of "invention" has constituted the sole and only issue in thousands of contested cases which have been passed upon by the patent office and by the federal courts, not one of these august tribunals has ever succeeded in laying down a definition of that which constitutes invention? Listen to the observations of a learned judge of the supreme court of the United States:

"The truth is, the word [invention] cannot be defined in such a manner as to afford any substantial aid in determining whether a par-

ticular device involves an exercise of the inventive faculty or not. . . . . In a given case we may be able to say that there is present invention of a very high order. In another we can see that there is lacking that *impalpable something* which distinguishes invention from simple mechanical skill."* Is not this condition of mental confusion readily explicable, in view of the suggestion contained in the title of this paper?

Professor Robinson, perhaps the leading authority to-day, at least in the United States, upon questions of this kind, says:

"The mental faculties employed in the inventive act are the creative, not the imitative, faculties. An invention is the product of original thought. It involves spontaneous conception of some idea not previously present to the mind of the inventor. Industry in exploring the discoveries and acquiring the ideas of others, wise judgment in selecting and combining them, mechanical skill in applying them to practical results,—none of these are creation, and none of these enter into the creative act. Only when the mind of the inventor originates an idea new to himself, if not to all the world, does he call into exercise his own inventive skill, and perform the mental portion of the inventive act."†

If the above extract does not embody the popular conception of the nature and attributes of invention referred to in the first paragraph of this paper, I am at a loss to know what meaning is to be attributed to it. I take direct issue with the propositions laid down by Professor Robinson, and contend that the very qualities, faculties, and acts stated by him to be foreign to invention are those which constitute its very essence. It is assumed that something is *created* in the mind of the inventor; that something which had no previous existence is spontaneously generated there. On the contrary, I say that the mind of the inventor is a selective mental apparatus, in which material gathered from the outside is rearranged and adapted to new uses, and that this is nothing different from the normal operation of the human mind in all other operations. If this is not true, and if invention in fact is something other than this, then I can only say that the possibility has been demonstrated that, by the exercise of those faculties of the mind which are "foreign to invention" and those only, results may be produced which are absolutely undistinguishable from "invention of a very high order." If, on the contrary, my contention is well-founded, and there is really no such thing as the so-called "inventive faculty," and if the act which we call invention is nothing more than the normal result of the operation of mental endowments

* McClain v. Ortmeyer, 141 U. S., 419.

† Robinson on Patents, vol i, sec. i., par. 78.

of which all are possessed in a greater or less degree, it must logically follow that, inasmuch as our mental faculties are admitted to be no less capable of cultivation and improvement than our physical faculties, the power of invention or the capacity to invent may be improved and strengthened. It further follows that the operation of these faculties, like other processes, must be capable of being reduced to a definite system, governed by well-defined laws, with manifest advantage in respect to economy of time and effort and certainty of result.

Despite the unscientific and hap-hazard way in which these important results are attempted to be reached, we boastfully speak of the present time as the "Age of Invention." To me the past and present ages, as respects invention, seem ages of pure empiricism, which bear to the future and real "Age of Invention" much the same relation that the last century bears to the present in respect to theoretical and applied science.

Examine at random any one of half-a-dozen lines of mechanical invention; one striking characteristic, common to almost all, instantly arrests the attention; they present nothing more than a mere outgrowth of the manual processes and machines of earlier times. Some operation, once performed wholly by hand-tools, is expedited by some device which enables the foot as well as the hand to be utilized. Then power is applied; the hand and the foot operation, or perhaps both, are made automatic, and possibly, as a still further improvement, several of these automatic devices are combined into one. The fundamental basis is the old original hand-process, and hence, except in the extremely improbable event that this was the best possible method of accomplishing the result, all the successive improvements are simply in the direction, not of real novelty, but of mere modification and multiplication.

This inevitable tendency of the human mind to follow along well-worn grooves of habit serves to explain the reason of a fact often noticed,—namely, that the most radical and important departures from old methods, by which many of the industries of the world have been completely revolutionized, are nearly always originated by persons wholly ignorant of the accepted practice in the particular industry concerned. There is no conservatism so unyielding as that of the specialist. It is one of the most insidious enemies which the inventor has to encounter; it is so easy to take things for granted, to let well enough alone. It is this and other considerations of no less significance that I have in mind when I say that the Age of Invention is not yet; we see only its vague and ill-defined fore-glimmer.

The ideal invention is as positive as a geometrical demonstration;

hence the actual invention should at least be the logical mechanical complement of the conditions incident to the operation to be performed; it should be the logical answer to the problem which has been set, and should change only when external conditions change. Therefore an improvement on an invention should be of rare occurrence. The true and complete solution should be reached in the first instance.

I cannot close this line of argument without insisting upon the fact that the first and most important prerequisite to invention is an absolutely clear insight into, and a comprehensive grasp of, all the conditions involved in the problem. My own experience leads me to believe that this prerequisite alone constitutes nine-tenths of the work of invention, and that the remainder, in most cases, practically invents itself, or, to be more accurate, flows therefrom as a logical sequence.

And now, if it be admitted that invention is not an impalpable and indescribable "something," but that, on the contrary, it is the result of wise judgment and trained mechanical skill coöperating to select, combine, and apply observations and conceptions already accumulated, what then?

My answer to this is two-fold, inasmuch as it necessarily implies two radical and far-reaching departures from existing conditions. The first change should consist in eliminating from patent law and patent practice the conceptions which attach to the words "invention" and "invented," and in substituting therefor the ideas embodied in the words "discovery," "discovered," "produced," "thought out," "reasoned out." The mere change of phraseology would in itself go far to put an end to the existing maze of confusion, incident to the determination of the ever-recurring question whether a given device does or does not involve that undefinable, "impalpable something" which the law says is the indispensable requisite to patentability, and would restrict the whole scope of the inquiry to the comparatively simple questions of novelty and utility. The second, and by far the most important, change should consist in the inauguration of a Science of Invention, with all the attributes which that phrase implies. Impressed as I am with the transcendent importance of this branch of the subject, I venture to offer such suggestions as have occurred to me, in the hope that others more competent may be induced to take the matter in hand, and give it the consideration which its importance warrants.

The following should form (in part) the basis of a scheme for the Cultivation of Invention:

1. Accurate and methodical observation.
2. Cultivation of memory, including the faculty of association.

3. Cultivation of clear visualization.

4. Logical reasoning from actual observations.

Particular importance should be attached to accurate observation, inasmuch as this is the indispensable foundation of all real education.

With the above considerations in view, a course of training in which the following exercises are included has suggested itself to me.

First. Drawing from simple objects (not copies) under the following conditions: the object to be carefully examined, then removed, and a drawing made wholly from memory; this to be repeated until the last effort depicts the object as correctly as if drawn directly from it; each successive drawing to be on a separate sheet and removed from view while the succeeding one is in progress; when considerable proficiency has been attained, more complex objects to be substituted, and the time interval increased; the class of objects to have as wide a range as possible; as proficiency increases, the time allowed for preliminary observation to be shortened, until the briefest possible glance at an object shall be sufficient to impress its appearance clearly upon the mind, the power of visualization becoming so highly cultivated that at any future time the image may be called up and reproduced with absolute fidelity of detail; as a modification of the foregoing, drawing objects from description, oral and other.

Second. Other exercises of the same general character, with or without the aid of drawing, having reference to other characteristics than form, as, for example, material, structure, and function.

Third. The solution of problems pertaining to the construction of the sample object, its manufacture and improvement, together with the discovery of means for the accomplishment of definite ends. These are, of course, merely suggestions, the scope of which may be extended and modified almost indefinitely. It may perhaps be objected that, while the first and second of the exercises above suggested might have the effect of cultivating the mental capacity for accurate observation, retentive memory, and clear visualization, the third would often prove to be beyond the scope of the ordinary mind. That such is not the case I am able to show by citing as an example the invention of an actual machine of no inconsiderable utility, for the purpose of assembling fruit-cans in the process of manufacture. For convenience of description the experiment is thrown into the form of a colloquy.

Q. Of what shape is a fruit-can? *A.* Cylindrical.

Q. What is the principal peculiarity of the cylindrical form? *A.* Roundness.

Q. What does this adapt it to do? *A.* Roll on a plane surface.

Q. To provide means of conveying cylinders a short distance in the simplest manner, how would you proceed? *A.* Make an inclined plane.

Q. Then, to convey bodies and heads of cans to a place to be operated upon, what would you provide? *A.* Inclined planes.

Q. Suppose you had to unite two pieces of stove-pipe in the usual way; how would you go about it? *A.* Hold them carefully opposite each other; then shove them together.

Q. Suppose you had to unite many such pieces of stove-pipe in lengths of two, and to do it quickly? *A.* Fix something that would hold them opposite each other, and then shove them together.

Q. Now, with regard to the tops and bottoms of fruit-cans; how would you assemble them? *A.* The same as stove-pipes.

Q. How is that? *A.* Let them roll down into something which will hold them in line with one another, and then shove them together.

Q. How will you make room for the next ones? *A.* Let the finished ones roll away.

Q. How would you instruct a mechanic to build your machine? *A.* Make three inclined runways, one for the can-bodies and one on each side for the covers. At the lower end of the runways, make something that will hold these three things in line with each other. Then fix something that will push all three together, and make a runway for the finished cans to roll away.

Will any one deny that the above course of reasoning is not within the capacity of an intelligent boy of 12 years of age, or that a mechanic skilled in the construction of such machinery could not build a practically operative can-heading machine from the above specification?

A course of instruction such as I have attempted to outline would serve to confer upon all capabilities now enjoyed only by the few, and would give to them such capacities for dealing with novel and unexpected problems and conditions as would vastly increase the productive capacity of the community. Language fails me in attempting to express my sense of the vast importance and urgent necessity of systematic culture and education in the direction which I have indicated. The Science of Invention should take its place as the first study in the kindergarten, and the test of proficiency therein should be the last one to which the student should be subjected before leaving his Alma Mater to struggle with the ever new problems which will surely confront him in actual life.

It requires far more than the necessarily brief space which can be allotted to a magazine article to treat this subject in the manner which its importance demands, but I trust that enough has been said to show that such a course of training, if generally adopted, would vastly increase the dominion of man over the forces of nature, and immeasurably hasten the advent of the real Age of Invention.

ILLUMINATING GAS FOR HEATING PURPOSES.*

By Frederick Siemens.

THERE is hardly any more important and more difficult question to be solved than the rational heating of dwellings. This is evident from the fact that, though many systems and constructions have been applied, not one exists which meets all the requirements.

A heating appliance must be cheap, not only as to first installation, but especially as to operating expense; it must be easy to attend to, and must not require any intelligent attendance; and, above all, it must be agreeable, and not detrimental to the health. Furthermore, it must be easily regulated, preferably by an automatic device, and must not cause any nuisance outside; for instance, it must not evolve any smoke,—that being very often the cause of complaints in otherwise good heating installations.

How are these requirements met in practice? The first installation is too expensive in most of the central heating systems, which show lesser or greater deficiencies according to the system employed. The hot-air heating system has a very disagreeable effect on the organs of respiration, for the reason that the air is hot and dry; from a hygienic standpoint, therefore, it is to be condemned, because the air which we breathe should be cool and nearly saturated with moisture. On the other hand, the existing systems are too expensive in operation, as, for instance, the English grate, which probably best meets the hygienic requirements in a dwelling, but which vitiates the air of the neighborhood—at least in large cities—with the escaping smoke and other products of combustion. The English grate heating system is very expensive on account of the large waste of fuel, and because it makes necessary a continuous care of the grate; in other respects it is agreeable and comfortable, mainly because only *radiating heat* is employed, similar to the heat from the sun, which is certainly the most agreeable and hygienic heat. Heating by large porcelain tile stoves is cheap, but from a hygienic point of view it is bad, as almost no radiating heat is obtained. The convection of heat by means of these large, moderately-heated porcelain stoves is effected in the main by the circulation of the air, as the air in the room rises against the heated surfaces of the stove and falls against the cooler walls of the room.

* Translated by F. B. Badt from a paper read before the Eighth International Congress for Hygiene and Demography.

The advantage of the porcelain stoves consists in the moderate degree to which the surfaces of the stove are heated, but from a hygienic point of view this mode of heating must be condemned, because the effect is about the same as that of the hot-air system. The circulation of the air, as described, heats the air of the room, while in the English grate system the radiating heat leaves the air of the room cool, but, on the other hand, heats the walls and all the objects in the room in exactly the same manner as the sun heats everything in nature. Another very uncomfortable, but simple, method of heating is by means of the so-called "Cannon" stoves. These stoves are usually made of iron; they get very hot on the outside, and therefore radiate much heat; they act less by heating the air than by radiation, but they vitiate the air in the room in other respects to a very high degree. The heated iron permits the poisonous gases of combustion (for instance, carbonic acid gas) to pass through it; besides, the air in the room rises against the hot surfaces of the iron stove as in the case of the porcelain stoves; only the air gets heated to such a degree that it burns and carbonizes many particles of dust composed of organic substances always prevalent in air. This causes a highly disagreeable odor, which will always be found where stove surfaces heated to a high degree are exposed to the air of the room.

I classify under the heading "Cannon" or "Iron Stoves" all stoves whose external surface is heated to more than 212° F. These iron stoves exist in innumerable types, and are made under many systems, but are usually employed only as makeshifts, it being unbearable to any human being to breathe for any length of time the half burned and singed organic matter contained in the air.

It can be easily seen that the temperature of the surface of a stove should be kept below 212° F. This is the reason that in all countries with cold and long winters, where the necessity for heating apparatus is the greatest, the large, moderately-heated porcelain stoves are generally used; while in countries with moderate winters the iron stoves prevail, because heating apparatus is used rather exceptionally. In all central heating systems the low-pressure steam heat is preferred, although the first cost and the operating expenses are comparatively high on account of the large heating surfaces needed. The air under system is more agreeable and healthful than in cheaper installations, which operate with smaller heating surfaces and higher temperatures.

I might go into still more detail in these comparisons, but I assume that I shall be readily understood when I say that, for heating dwellings, the ideal apparatus is one which generates a large amount of radiating heat, but exposes only very moderately heated surfaces. This leads me to the consideration of the regenerative gas stove,

which was constructed to meet these ideal conditions. As a common gas flame does not radiate over 30 per cent. of its heat, I increase this percentage by using an intensely white regenerative gas flame, similar to that used for lighting purposes. Such a flame radiates, on account of its much higher temperature, at least twice as much heat as does the common gas flame: however, the escaping products of combustion of the very hot flame convey less heat to the stove, because the regenerator absorbs most of the heat of combustion for the purpose of heating the necessary amount of air previous to combustion.

In order to make myself clear on the subject, I want to state that I commenced about twelve years ago to manufacture heating stoves for illuminating-gas and with regeneration of heat, which were also called accumulators. In 1885 I obtained my German and other patents, and I then commenced to offer such stoves to the public. The result was that a good many competitors appeared, offering stoves to be used with illuminating gas, partly with and partly without radiating heat, but all without a heat accumulator. In the beginning these gas-heating stoves did not find favor, partly on account of the erroneous supposition that the use of illuminating gas would be too costly, and then because the intensely illuminating regenerative gas flame had a blinding effect on the eye. When, finally, a few years ago, during the Brussels Exposition, such a stove, without a regenerator or accumulator, made its appearance, in which the heating radiating gas flame was invisible, but gave its effect indirectly by means of a copper reflector, it found more favor with the public. Since the appearance of the indirectly operating reflector, which I employ also, the demand for regenerative gas stoves has increased considerably, in spite of the many competitors who do not employ regenerative apparatus, but succeeded nevertheless in selling a good many stoves on account of their cheapness, and because they called them "regenerative" or "double regenerative." I would not care about this competition if the public were not deceived by cheap stoves, falsely called regenerative, thereby injuring the reputation of the system. As it would take too much space to relate the whole business development of my heating system, I confine myself to its description as it stands to-day.

The drawing (Figs. 1 and 2) shows, in two cross-sections, that the heating apparatus consists of two main parts,—*viz.*, the simple radiating grate arrangement "A," and the stove "B," which is built over the grate for the complete utilization of the remaining heat. The gas heating flame is formed by leading illuminating gas through the horizontal pipe "v," which is located above the reflector "r"; the pipe contains in the forward direction one or more fine holes through which the gas can escape in horizontal flames.

The air necessary for combustion flows in the beginning, when the apparatus is cold, out of the space in front of the reflector to the burners. The flames are pointed horizontally and forward (compare drawing), and radiate a great deal of their heat on the reflector "r"; then they are led through the downward channel "m" of the regenerator "C," and then again forward through the channel "n" in the upper part of the stove "B," and finally escape through the stove pipe "E." In leading the products of combustion downward the regenerative apparatus is heated as contemplated. The necessary air of combustion, which is of course cold, enters now through the vertical regenerator channel "e" from below; the air then moves in a direction opposite to that of the products of combustion, which are moving downward in shaft "n," and in this manner the air absorbs the greater part of the heat of the products of combustion; then, highly heated, the air mixes from above and below, with the gas escaping out of pipe "v." The air channel "e," on account of its heating by the product of combustion and on account of its almost vertical position, becomes a small chimney, and conducts the hot air to the gas flames automatically,—*i. e.*, independently of the main chimney "E." This automatic conveyance of the hot air is a highly important requirement, because the whole heating apparatus becomes independent of the unreliable draught of the chimney, and may be employed even where there is no chimney at all. In the latter case, however, the products of combustion would escape into the room, which must be obviated for hygienic reasons. The products of combustion, already considerably cooled in the regenerator "C," now heat, in the moderate manner desired, the upper part of the apparatus, the real stove "B," which consists of a number of boxes (k k k) so arranged that they leave spaces and constitute a large extended heating surface, in order to utilize in the best possible manner the remaining heat.

Provision is also made for the evaporation of water in the upper part of the stove, in order to saturate to a certain extent the dry air generated by the stove "B."

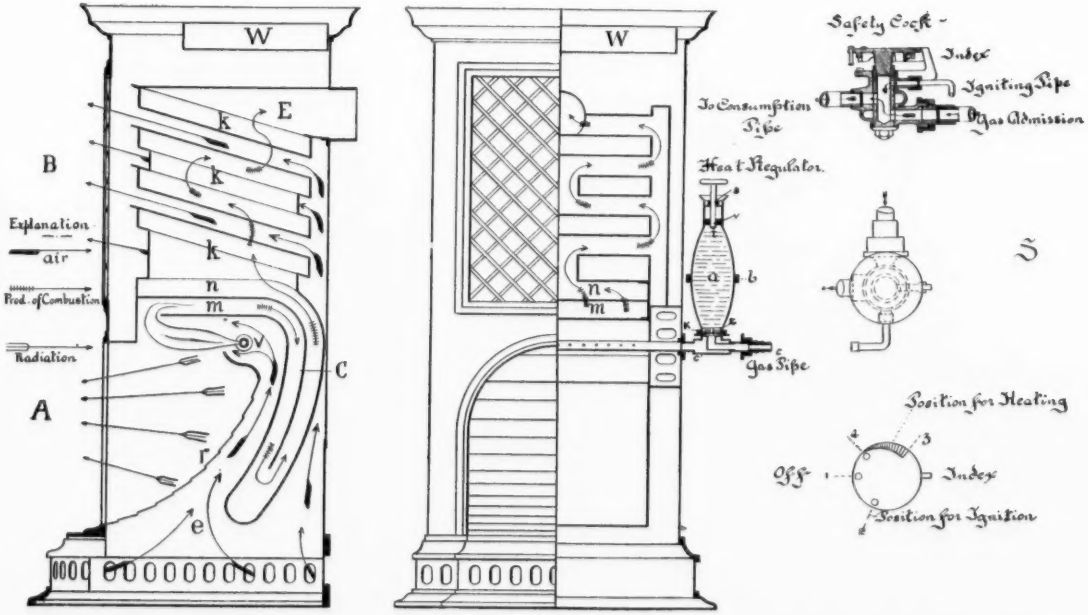
An important part of the whole heating apparatus is the reflector "r," which, as can be seen from the drawing, is so arranged that the rays of light and heat falling on it from above are reflected forward and sidewise, while the intense white flame itself cannot be seen from the room.

By means of the reflector, whose material, color, and surface are so selected that the rays of heat are thrown completely into the room without disturbing the eye by the rays of light or the images of the burners, the room is mainly heated in the lower part, so that at the

height of, say, 5 ft. the temperature is considerably lower than at the floor. By such an arrangement the comfort is greatly increased and a waste of heat is prevented,—a waste which must exist when, as in the other heating systems, the ceiling of a room is heated while the floor remains cold. I describe the upper part of the heating apparatus, the real stove "B," only superficially, because this part does not show any novelty and might even be omitted under certain conditions. Where considerations of the greatest economy do not exist, it might be well to use only the lower part of the heating apparatus, the real grate "A," with its excessive radiation of heat. With the small surfaces of the stove "B" and with its low degree of heat, the effects of the stove must be the same, though in a small degree, as in the large porcelain stove already described. As, by means of the regenerative system, a much greater part of the heat generated by combustion is converted into radiating heat and led to the room in the most advantageous manner, it is the more advisable to do away with the stove "B." Lately this arrangement has met with much favor, especially in the more luxurious dwellings.

Another highly important advantage, which is made possible only by the application of illuminating gas for the generation of heat, consists in the possibility of the application of an automatic regulator. This heat regulator, which may be adjusted for any desired temperature, raises or lowers the temperature by permitting more or less gas to flow to the burners. This arrangement not only adds to the comfort, but prevents the waste of gas. It is fair to assume that the consumption of fuel in all other heating systems is increased by the lack of an automatic heat regulator, because the heating is effected without regard to the existing temperature. The consumption of fuel, of course, could be diminished if an economical mode of heating were adopted, but this is not alone sufficient; it is necessary also to adjust the heating in accordance with the continually changing demand for heat. As the automatic heat regulator permits the use of fuel in exact proportion to the momentary demand, and as the generated heat is directed by means of the reflector to the place where it is needed, the gas heating stove shows an actual saving in fuel in comparison with all other systems, in spite of the comparatively high price of illuminating gas.

The heat regulator constructed by me is illustrated in Fig. 2. It consists of an oval metal vessel "a," to which is attached below a telescoping arrangement "z," made out of thin tin. To the lower end of the telescoping arrangement is attached a small cone "k," which serves to regulate the flow of gas through the pipes "c" and "c^1," "c" being inside of "c^1." Pipe "c" is connected with the gas service pipe, and "c^1" with the stove. The flow of the gas is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Gas Admission
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Position for Ignition

indicated by the arrows. The vessel "a" is provided in its upper end with a small pipe "r," which terminates in a little funnel "t"; the latter contains a little needle valve "v," which may be opened or closed by means of thumb-screw "s."

The whole apparatus is filled with water in such a manner that the water becomes visible in the funnel and does away with air bubbles. Hoop "b" may be compressed by means of a screw, thus compressing vessel "a" more or less, so that the water in the funnel will visibly rise or fall.

Just as soon as the whole apparatus is regulated so that cone "k" at a certain temperature, say 54° F., with the needle valve "v" closed, permits a sufficient amount of gas to pass, the water in vessel "a" will expand with any rise of temperature; this will cause the telescoping arrangement to move cone "k" in a downward direction, and consequently the flow of gas will be partially or entirely shut off. If the water in the vessel "a" cools, the telescoping arrangement will contract, and the cone "k" will again permit the passage of the gas in proportion to the degree of temperature.

The advantage of such a temperature-regulator over other well-known devices lies in the fact that, in case of escape of the liquid, which will occur in the course of time, the needle valve "v" may be opened, and water may be added through the funnel "t," until the apparatus is again properly adjusted.

Another important device is the safety cock "s" with self-igniter. (Fig 3). This cock is so constructed that it can be turned only in one direction and only step by step. If the index points to step 1, the cock closes. If the index turns to step 2, the igniting flame touches the gas service pipe. The next step connects the gas service pipe with the main flame. This is ignited on the igniting flame, and the latter is again shut off, so that, when the index points to step 3, only the main flame is burning and the ignited flame is shut off. Between steps 3 and 4, the hand may be moved to and fro for the admission of more or less gas, as indicated by the scale.

If it becomes necessary to extinguish the flame, the index is set to 1. Such a safety device is very important, because without it negligence and ignorance may cause many bad results. Even malicious intent could cause an irregularity only when assisted by technical knowledge.

In closing this paper, I beg to draw your attention to the fact that probably illuminating gas will be superseded to a very large extent by the electric light. It is, however, a rather curious coincidence that electricity for heating can find only a limited application, while, on the other hand, illuminating gas is particularly adapted for it. The

illuminating gas as fuel is not only applicable for heating stoves, but for all feasible domestic and technical purposes ; it is well adapted for cooking, melting, annealing, and other operations. It has become more and more evident that illuminating gas is particularly adapted for heating purposes on account of its great radiation of heat, radiating heat being the best for heating purposes. Where heating by contact is required, we may apply the Bunsen or similar burners, so that even for these purposes the illuminating gas can be used to advantage. I beg to remind you of the Auer incandescent light, and various cooking and heating apparatuses.

In most of the heating and melting operations, especially in all cases where the regenerative system can be used with advantage, it is the radiating heat that we want, as I pointed out some years ago in my many papers read in Germany and England. I refer to these papers and the many successes which I have achieved with my regenerative gas stoves in many technical industries, especially in the glass and steel industries.

I think I may predict that the present illuminating gas will gradually change its *rôle*, and will be used in future mainly as fuel. Especially in large cities would this change be advantageous ; but, in order to obtain this result, the illuminating gas, or, rather, the heating gas, must be considerably reduced in cost. Prospects for such reduction are good, because gas prices have been continually on the decline, and larger competition and the great progress made in the methods of manufacturing gas will contribute their share, especially if the gas is used to a larger extent for heating purposes.

ROBERT FULTON AND HIS STEAMBOATS.

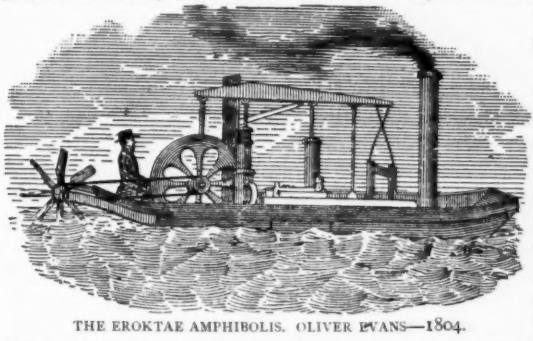
By T. C. Purdy.

TWELVE years from this August we may celebrate the centennial anniversary of the first trip of the steamer "Clermont" up the Hudson river. It is to be hoped that the event will be commemorated with a grand pageant of modern steamers, proceeding over the historic route; and among them, I trust, will be found some large vessels propelled by stored electricity, thus opening the century as propitiously with this new force as the ending century was opened by Watt, Fitch, Fulton, Stevens, and Symington. In view of the possibility of such a celebration, we may discuss Robert Fulton and his work, in order to form a correct estimate of the man and ascertain the bearing of certain data upon the important events of his life.

According to a writer quoted by Admiral Preble in his "History of Steam Navigation," Fulton named the Clermont the Katharine of Clermont, after Katharine Livingston, of Clermont Manor. August 7, 1807,—the date usually given for the starting of the Katharine of Clermont on her first trip from New York up the Hudson,—was Friday, and it is certain that the voyage was not begun on that unlucky day, but that it took place on the 17th of August, some careless writer having dropped the 1 from the number 17, thus causing August 7 to be accepted as the date by many historians. August 17, 1807, was Monday, and Fulton published a letter in the *American Citizen* describing the trip, in which he says: "I left New York on Monday at 1 o'clock, and arrived at Clermont, the seat of Chancellor Livingston, at 1; time, 24 hours; distance, 110 miles. On Wednesday I left the chancellor's at 9 in the morning, and arrived at Albany at 5 in the afternoon; distance, 40 miles; time, 8 hours. The run is 150 miles in 32 hours,—equal to nearly five miles an hour. On Thursday at 9 o'clock in the morning, I left Albany, and arrived at the chancellor's at 6 in the evening. I started from there at 7 and arrived at New York at 4 in the afternoon; time, 30 hours; space run through, 150 miles,—equal to 5 miles an hour. Throughout my whole way, both going and returning, the wind was ahead. No advantage could be derived from my sail. The whole has therefore been performed by the power of the steam-engine," etc.

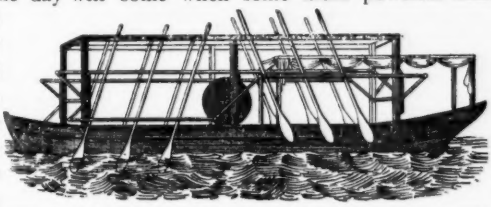
A letter from a South Carolina gentleman, published in the British *Naval Chronicle* and written under date of September 8, 1807, says: "I have now the pleasure to state to you the particulars of a late excursion to Albany in the steamboat made and completed under the

direction of the Hon. Robert R. Livingston and Mr. Fulton. On the morning of the 19th of August, Edward P. Livingston, Esq., and myself were honored with an invitation from the chancellor and Mr. Fulton to proceed to Albany, in trying the first experiment upon the Hudson in the steamboat. She was then lying off Clermont, the seat of the chancellor, where she had arrived in 24 hours from New York, being 110 miles."

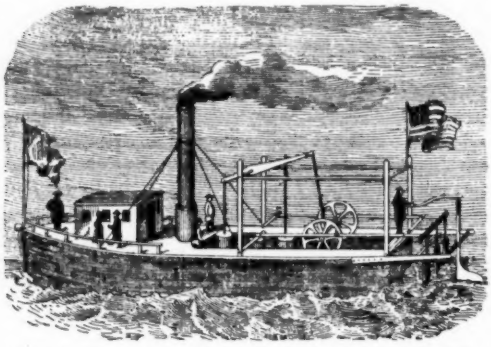


THE EROKTAE AMPHIBOLIS. OLIVER EVANS—1804.

In justice to other inventors, and to arrive at a correct estimate of Robert Fulton's part in the development of the steamboat, we may discuss his merits as an inventor, adapter, and shrewd business man, ready to take advantage of any suggestion at hand and of results attained by others in this line of invention. It is a historic fact that he had made himself familiar with the discoveries in the use of steam up to the date of his successful experiment, and was thus able to avoid the errors that other inventors had made. No class of brainworkers suffer more from plagiarism than the engineers of this country, and they will readily sympathize with John Fitch in this wail taken from his journal: "The day will come when some more powerful man will get fame and riches from my invention; but nobody will believe that poor John Fitch can do anything worthy of attention." In 1785 Robert Fulton was living in Philadelphia, following the vocation of a miniature painter, and was undoubtedly familiar with the work that Fitch had done there, as it had been made public before he left that city. Later, it is claimed, he had Fitch's drawings in his possession while living in Paris. English writers declare that in 1801 he visited Symington's boat on the



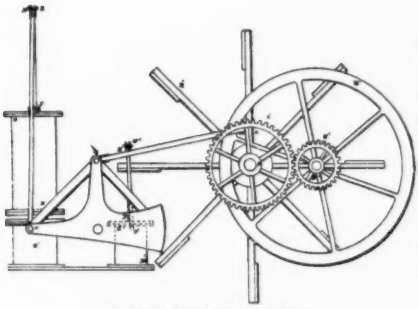
FITCH'S SECOND BOAT—DRIVEN BY PADDLES, SIX ON A SIDE; AS SIX CAME OUT OF THE WATER SIX MORE ENTERED.



FITCH'S THIRD BOAT—DRIVEN BY PADDLES AT THE STERN.

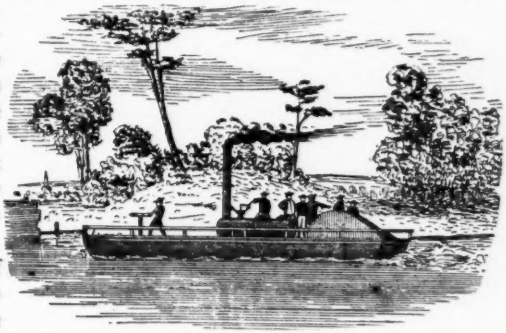
Forth and Clyde Canal, and made drawings of the machinery and took an 8-mile trip on her, going at the rate of 6 miles per hour. He also met a Dr. Cartwright in England, who had made experiments in steam navigation, and who confided his plans to him. Thus armed, and backed by Chancellor Livingston and his money, he produced the Katharine of Clermont and became famous. He never made a strong claim to the invention of the steamboat, but claimed the perfection of its machinery and the adjustment of its parts. After Fulton's death, which occurred on February 24, 1815, the Fulton Steamboat Company was organized under the laws of the State of New York, on April 18, 1815, with a capital of. $250,000 The following is a list of the boats constructed by Fulton and his associates in this company:

Name.	Year.	Tonnage.	Route.
Clermont	1807	160	Hudson River.
Car of Neptune	"	295	" "
Raritan	1808	120	" "
Paragon	1811	331	" "
Fire Fly	1812	118	New York to Newburgh.
Jersey (Ferry)	"	...	" " " Jersey City.
Richmond	1813	370	Hudson River.
Washington	"	275	Potomac River.
York (Ferry)	"	...	Jersey City and New York.
Nassau "	"	...	Brooklyn to New York.
Fulton	"	327	Long Island Sound.
Fulton First	1814	2475	United States Navy.
Olive Branch	1816	265	New York to New Brunswick.
Connecticut	"	351	Long Island Sound.
Chancellor Livingston	"	495	Hudson River.
AT PITTSBURGH.			
New Orleans	1811	371	Mississippi River.
Vesuvius	1814	340	" "
Ætna	1815	360	" "
Buffalo	"	249	" "

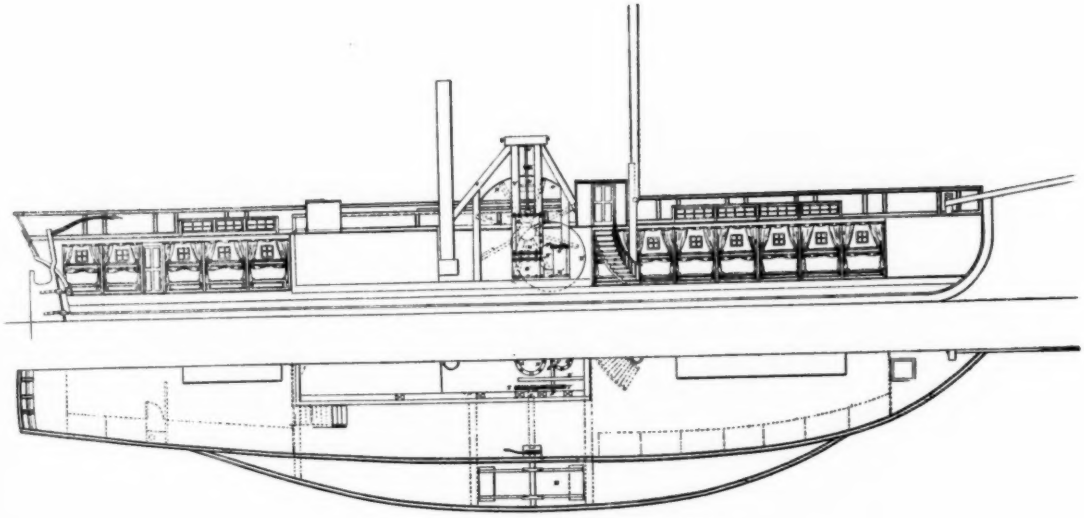


THE CLERMONT GEARING.

With the destruction of the public buildings at Washington by the British in 1814, we lost all of the drawings and specifications of the early American inventors. We therefore possess but very meager information of an authentic character regarding the construction and modeling of the early steamers. The French government became interested in the wonderful development of steam navigation in this country, and sent an engineer here in 1822 to make a report. There is but one copy of this report in this country; I have had tracings of the drawings made, and have translated a portion of the text with a view of publishing it in the form of a history, but have not done so as yet. These drawings and records give the most authentic information that we now have in this country; they were the work of an expert, and covered the field with no bias for the work of any particular inventor. These drawings would enable us to reconstruct some of Fulton's masterpieces, like the Fulton, or the Chancellor Livingston. The hull and engines of the one and sectional and deck plans of the other are herewith presented pages 872 and 874. The Livingston was undoubtedly the most complete of Fulton's steamers, though she was finished after his death. Great care was taken in her construction, and nothing was spared to render her superior to all other boats of her day in the luxury of her appointments. She was sheeted with copper, and cost $128,000. The principal part of the engine was placed in the middle of the hull, and the rest of the machinery aft. The cylinder was 40 in., with a stroke of 5 ft.; and up to 1820 she was the only steamer in



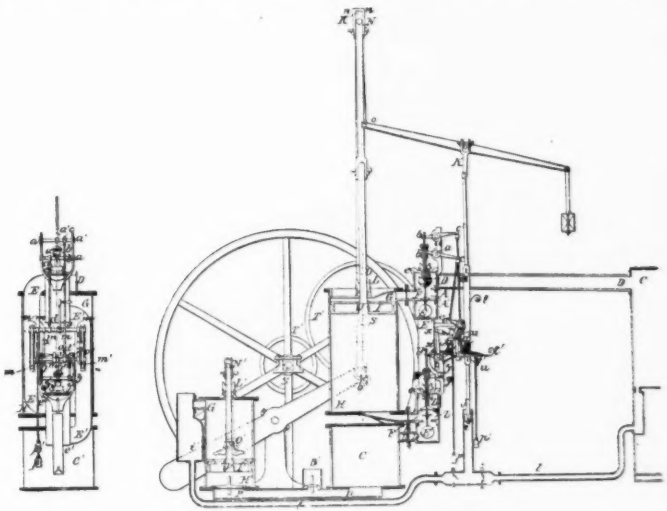
SYMINGTON'S BOAT, DRIVEN BY A STERN PADDLE-WHEEL.



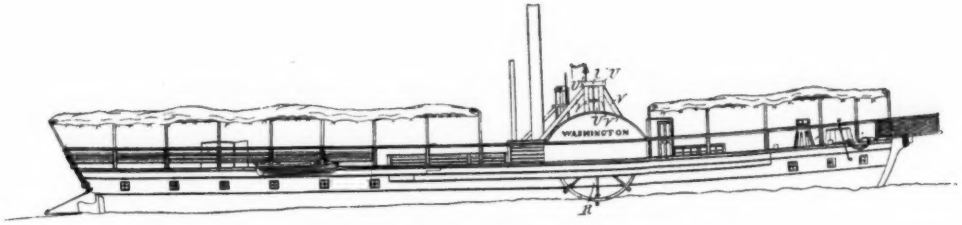
THE FULTON, LONG ISLAND SOUND, 1813.

the Eastern States in which coal was used. She ran from New York to Albany in 20 hours,—a distance of 150 miles, the wheels making seventeen revolutions per minute. Nearly all the engines in the Eastern States in 1820 were modifications of that in the Chancellor Livingston shown below. It was a low-pressure engine taking the steam at both ends of the cylinder. The principal cylinder, *GH*, was vertical,—the condenser, *C'*, beneath, and to the right a portion of the boiler, *C*. The connecting pipe, *D D E E*, carried steam from the boiler to the cylinder, and two valves, *A*, and *Z*, admitted it, one above and one below the piston, *I*, and two other valves, *A'*, and *Z'*, let it pass out into the pipe, *E' E' D' D'*, which led to the condenser, where it was met by a jet of cold water. This water, air, and vapor were then taken up by the air-pump, G' H', through the pipe, *P P*, into which the valve, *B*,' opened, and carried into the hot well, *i'* and through the force pump thrown back into the boiler, *C*.

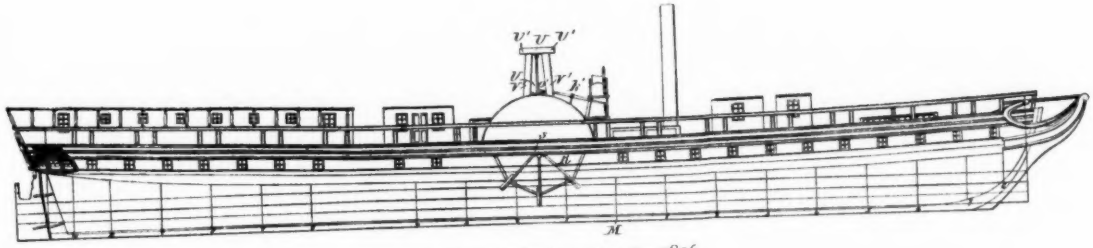
On page 874 is given a correct drawing of the hull of this famous boat. In 1832 she was bought by Mr. Cornelius Vanderbilt and Mr. Amos H. Cross of Portland, and put upon a route between that city and Boston. At that time she had her third engine, which was a square or cross-head engine. In 1834 the Chancellor Livingston was broken up, and her engines were placed in the Portland. On



ENGINE OF THE CHANCELLOR LIVINGSTON.



THE WASHINGTON—1813.



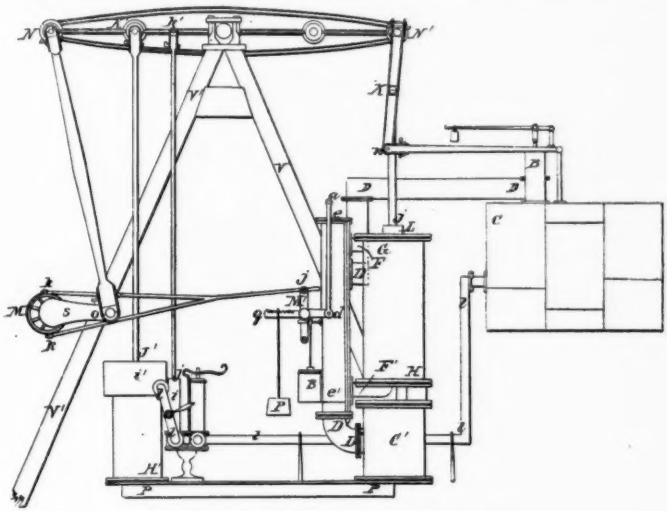
THE CHANCELLOR LIVINGSTON—1816.

page 872 are presented the deck plan and a sectional view of the steamer Fulton, of 327 tons and built in 1813. According to the French government report, the Fulton cost $93,000, and the boiler alone is said to have cost 32,000 francs. It was 20 ft. long by 8 ft. high and 9 ft. broad. The mechanism of the engine did not differ much from that of the engine in the Chancellor Livingston. The Fulton ran from New York to Albany in 28 hours and 20 minutes. In 1814 she ran on a route from New London to New Haven, making 52 miles in 10 hours 43 minutes. She burned about 25 cords of wood on the trip. All the dimensions of her machinery are given in this report.

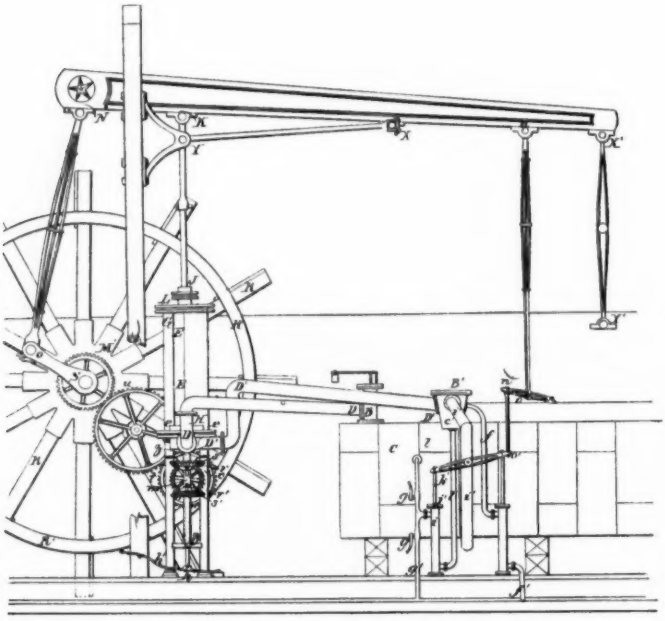
Below is given an Allaire engine, built for a Mississippi river boat in 1818. The parts will be readily understood. All the engines of this date were parallel motion engines, as will be seen by the drawings; only low-pressure engines were used in Fulton's boats.

On page 874 is given the hull of the Washington. She was built in 1813, and was brought around from New York into the Potomac in 1815. She cost $42,000, and was not sheeted with copper. The engine was 32 h. p. with a cylinder of 28″ and 4-ft. stroke.

A correspondent of the *National Intelligencer*, writing from Norfolk under the date of May 24, 1815, gives the following relating to the trip of this steamer from New York to that port. "We were last evening,



ENGINE FOR A RIVER STEAMER, ALLAIRE, 1818.

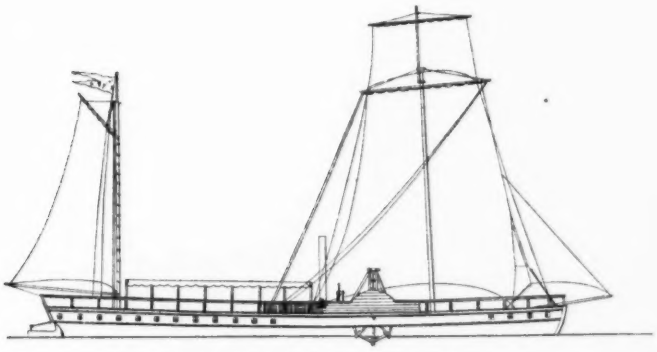


ENGINE OF THE ÆTNA. BUILT BY OLIVER EVANS—1815.

for the first time, gratified with the sight of a steamboat entering our harbor. The distinguished stranger is called the Washington, commanded by Captain O'Neal and owned by a company of gentlemen at Washington. We were in hopes that she would ply between this place and Richmond, but understand she is destined for the Potomac. On leaving New York, many were doubtful, thinking that she would not be able to perform the voyage, no vessel of that class having tried the sea before; but she made the trip in perfect safety, in a period of 50 hours. Her cabin is superbly fitted up with every convenience for the comfort and accommodation of passengers. Capt. O'Neal has politely favored us with New York papers of Saturday, 2 days later than those by mail."

She made the run from Norfolk to Washington in 30 hours, arriving there on June 1, 1815. She went on a route to Fredericksburg. She was followed by the Potomac in 1820, which ran between Washington and Norfolk.

No figure stands out with more prominence in the early history of



THE PARAGON—HUDSON RIVER—1811.

steam navigation in this country than that of Oliver Evans, the father of the high-pressure engine. On page 876 is shown one of his engines, —that of the steamer Ætna. This steamer was built in Philadelphia in 1815. She was 116 ft. long and measured 125 tons. Her engine was of 45 h. p., with a 20″ cylinder and a paddle-wheel 18 ft. in diameter, with a rim of cast iron serving in the place of a balance-wheel. The boiler, composed of several cylinders, was 23 ft. long and 8 ft. 6 in. in diameter, and was said to sustain a pressure of ten atmospheres. Nearly all of the engines in this country up to 1820 were low-pressure. In the engines of the Ætna, however, the pressure was raised to several times that of the atmosphere. Oliver Evans built engines at Philadelphia up to 1819, when his works were burned; he died April 21 of that year.

While honoring Robert Fulton for making a success of the steamboat, let us not forget that, like nearly all great inventions, it was a growth; many good men assisted in its development, and among them, deserving great credit, were John Fitch and Oliver Evans.

JAMES RUMSEY, STEAMBOAT INVENTOR.

By James Weir, Jr.

TO Robert Fulton is generally given the credit of having discovered the first method of propelling vessels through the agency of steam; yet it can be clearly shown that two men antedated him, even here in America, in this discovery. One of them preceded him by almost 20 years, the other by 18 or 19 years.

The man who, in America, first discovered a method of successfully propelling a vessel against wind and tide, with steam as the motive power, was James Rumsey. The government of the United States has recognized this to be an established fact, for in 1839 congress ordered a medal to be struck in his honor, commemorative of this brilliant achievement. James Rumsey was born of Scotch parents in 1754. Maryland was his native State, but he removed to Sheperdstown, Va., when about 20 years of age. He had all the native shrewdness and astuteness generally ascribed to the Scotchman. He was a man of fine presence, tall and powerfully built. While, strictly speaking, not an educated man, he was an omnivorous reader and well versed in matters pertaining to his profession,—civil engineering. He was a good talker, but a better listener, and his neighbors regarded him with respect and looked upon him as a man of undoubted genius. He early turned his attention to invention, and the writer had, until a short time ago, a pistol made by him, which shows his inventive capacity.

When Rumsey removed from Maryland to Sheperdstown, he entered the service of the Potomac Company as superintendent. While in the service of this company, he suggested many novel views in mechanics, and invented and put into operation numerous improvements in milling, especially in the application of hydraulics as the motive power. The steam engine was then in its infancy. Watt was just beginning to perfect his wonderful invention. Machinists were rude and unskilled in their profession, and Rumsey was forced to plan, model, and make his own machinery. He even did his most important casting himself,—making the moulds and running off the metal with his own hands. Testimony adduced before the house of representatives in 1839 shows that Rumsey had conceived the idea of steam-navigation as early as August, 1783 (*Cong. Record*). Laboring under very adverse circumstances, he succeeded in the autumn of 1784 in making a test of some of the principles of his engine and propelling apparatus. In October, 1784, the Virginia legislature passed an act "guaranteeing to him the exclusive use of his invention in navigating

the waters of Virginia" (Stat. Virg., 1784). About this time he wrote to General Washington, communicating to him the principles of his invention. General Washington wrote of Rumsey's invention to Governor Johnson of Maryland. This letter is dated November, 1787, and was produced before a committee of the house in 1839, at which time the following resolution was offered and passed:

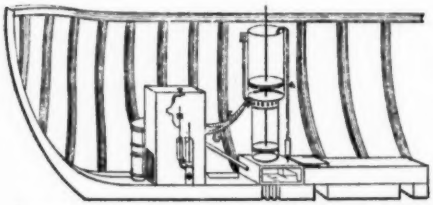
Resolved, by the Senate and House of Representatives of the United States of America in Congress assembled: That the president be, and he is hereby, requested to present to James Rumsey, Jr., the son and only surviving child of James Rumsey, deceased, a suitable gold medal, commemorative of his father's services and high agency in giving to the world the benefits of the steamboat.

In January, 1785, Rumsey obtained a patent from the general assembly of Maryland for navigating the waters of that State (Acts Gen. Ass. Maryland, 1785). During the whole of this year he was busy in the construction of a steamboat. In 1786 he successfully navigated this boat on the Potomac at Sheperdstown in the presence of hundreds of spectators.* The experiment was eminently successful, as was proven by the affidavits and personal testimony of numerous witnesses who testified before the above-mentioned committee of the house in 1839. Mr. Bedinger described the experiment in a letter which was certified by Dr. Alexander of Baltimore, a man of eminence and respectability. Rumsey succeeded in this trial in propelling his boat against the current by steam, at the speed of *five miles an hour.* There was for a long time, and may be now, in the possession of one branch of the Rumsey family a pamphlet, which has been seen by numerous people well known to the writer, containing "approbatory certificates of numerous gentlemen who witnessed the exhibition." Among the names signed to certificates was that of General Gates. Mr. Bedinger mentions General Gates's presence in the letter read before the committee of the house, as detailed above. The result of this trial was very encouraging. Dr. Alexander, who was on board, said: "Every person present believed that Mr. Rumsey had accomplished all his wishes" (*Cong. Record*, 1839). This successful trial took place in 1786.

According to information in the possession of the writer, Rumsey's method of propulsion seems to have been exceedingly unique.

* The *Cincinnati Enquirer* lately printed the following dispatch from Parkersburg, W. Va., relating to the trial of Rumsey's boat: "The first steamboat was really built by James Rumsey at Sheperdstown, Va. (now West Virginia). The boat was partially constructed in Frederick county, Md., in 1785. It was fitted up with machinery partly manufactured at a furnace called 'the Catoclin,' owned by Johnson Bros., near Frederick, and the two cylinders, boiler, pumps, pipes, etc., were built in Baltimore. Part of the work was done at the old Antietam Iron Works. The boat was 80 ft. in length, and was propelled by an engine which worked a vertical pump placed in the center of the boat. The water was drawn in at the bow of the boat and discharged at the stern through a horizontal pipe. The weight of the machinery was 665 lbs., and the boat's capacity was 3 tons. All of the machinery, including the boilers, took up a space of only a little over 4 ft. square. The first public experiment took place on the Potomac river on March 14, 1786."

Through the instrumentality of a powerful steam pump, water was forced through a battery of tubes placed at the stern of the vessel. The streams of water, striking against the surface of the river, shoved the boat along.



Rumsey's second boat (1788), propelled by water jet at stern. - Partial section, showing steam engine, furnace for tubular boiler, force pump, inlet valves and ejection passage.

The only man who can contest precedence with Rumsey is Fitch. It can be clearly shown, however, that Fitch's first experiment was not made until September, 1788, two years after Rumsey's final and successful exhibition on the Potomac at Sheperdstown. DeWarville, an eminent French writer, says in his work that, "being in Philadelphia in September, 1788, he attended by invitation, and witnessed, Fitch's experiment" (DeWarville, Cong. Library). DeWarville, in a note written in February following, while in London, says: "I have just met Mr. Rumsey of Virginia, a gentleman of great ingenuity, who proposes building a vessel in which, without sails, and by steam alone, he will cross the Atlantic in 15 days." After his successful experiment in 1786, Rumsey resolved to go to England. He believed that, with better workmen and better opportunities, he could cross the Atlantic in 15 days, in a steamboat built after his plans. He believed also that he could find in London the money for the furtherance of his designs. Slender means, while in the great city, often occasioned him to fall back on other inventions, and to abandon for a time his pet scheme, the steamboat, in order to replenish his purse. After long delays and many disappointments, he at last succeeded in building a boat of 100 tons burden. His machinery was so near completion that he had fixed a day for public trial, when his sudden death from apoplexy, while lecturing before a philosophical society, put an end to everything. Dr. John Hunter, writing of mental emotion inducing apoplexy, refers to Rumsey when he says: "The person who invented or applied the steam engine to the sailing of ships, and, who, when it was before the committee of the Society of Arts and Sciences, was taken at once with an apoplectic stroke, of which he died in about 24 hours." (*Posthumous Papers*, vol. 1, p. 264.)

Rumsey's letters to Mr. West, his brother in-law, show that he and Fulton were on intimate terms in London. Fulton was in London for the purpose of introducing his torpedo, but after Rumsey's death

turned his attention to the steamboat. It is definitely known that Fulton never gave a thought to the steamboat until after Rumsey's death This is shown in his letters to Lord Stanhope (Robt. Fulton Biog.). Fifteen years after Rumsey's death, Fulton succeeded in building a boat and running it against the current at the speed of five miles an hour. Rumsey, without assistance, without reflected light, did the same 20 years before. After Rumsey's death there was no one in his immediate family to attend to his numerous patents, and to push forward his inventions. His only son, James Rumsey, Jr., was blind and deaf from the effects of scarlet fever. His brothers possessed no mechanical or inventive faculties, and were engaged in other pursuits. The plans of this master mind ceased at his death, save only in the active brains of Fitch and Fulton.

Fitch was well acquainted with Rumsey's experiments, and had been present at the successful exhibition on the Potomac in 1786. He built a boat and successfully ran it in 1788. Fulton bided his time. Backed by Livingston, he made experiment after experiment, until in 1807 he perfected his arrangements and made a satisfactory trial of his steamboat. It is stated in Rees's Encyclopedia that Fitch made an experiment on the Delaware in 1783. This is not true; Fitch himself never claimed to have even thought of steam navigation until 1785. He made his first experiment on the Delaware in 1788 (DeWarville, Cong. Library). The testimony of General Bloomfield also fixes 1788 as the time of Fitch's experiment. (*N. Y. Review*, 1839.)

In the light of such testimony, we cannot fail to give the verdict of precedence to Rumsey, who successfully navigated his vessel, through the agency of steam alone, against wind and current on the Potomac in 1786.

ADDENDA.—These interesting contributions to the history of steamboat invention by Messrs. Purdy and Weir may be very appropriately supplemented by the following extracts from a little volume entitled, "Allegheny County's Hundred Years," by Geo. H. Thurston, published by Messrs. A. A. Anderson & Son, of Pittsburg, Pa., in 1888. From the chapter entitled "Boat Building in Allegheny Co.," beginning on page 99, we get the following interesting extracts.—THE EDITOR.

"Allegheny County is more than historically connected in a general way with the history of steamboat building. Elizabeth is the point where was built at the close of the eighteenth century the first sea-going vessel to navigate the western waters. * * * It would seem from the following extracts from the diary of one James

Kenny, a Quaker trader at Fort Pitt in 1761, that Pittsburg has some claims to being the place where the first germs of the idea of a steamboat originated. Says the diary:

"1761, 4th mo: 4th.—A young man called Wm. Ramsey has made two little boats, being squair at ye sterns, and joined together at ye stern by a swivel, make ye two in form of one boate, but will turn round shorter than a boat of ye same length or raise with more safety in falls and in case of striking rocks; he has also made an engine that goes with wheels enclosed in a box, to be worked by one man, by sitting on ye end of ye box, and tredding on treddlers at bottom with his feet, set ye wheels agoing, which work scullers or short paddles fixed over ye gunnels turning them round; ye under ones always laying hold in ye water, will make ye boate goe as if two men rowed; and he can steer at ye same time by lines like plow lines.

"There is nothing more on record of the young man called Wm. Ramsey, but the thought naturally occurs that, if he had persevered with his idea, Pittsburg was very near to being the scene of the first attempts to construct a boat to be driven with machine power. Where or when, however, the idea of a boat propelled by machine power or by steam originated is quite uncertain.

"From a work published about 40 years since in Spain, of original papers relating to the voyage of Columbus, preserved in the royal archives at Samancas, and those of the secretary of war in Spain, in 1543, it is stated that 'Blasco de Garay, a sea captain, exhibited to Charles V, in the year 1543, an engine by which vessels of the largest size could be propelled, even in a calm, without oars or sails. The emperor decided that an experiment should be made, which was successfully attempted on June 17, 1543, in the harbor of Barcelona. The experiment was on a ship of 209 tons, called the "Trinity." Garay never publicly exposed the construction of his engine, but it was observed at the time of the experiment that it consisted of a large cauldron of boiling water, and a movable wheel attached to each side of the ship.'

"A treatise was printed in London in 1737, describing a machine invented by Jonathan Hulls, for carrying vessels against wind and tide, for which George II granted a patent for 14 years. A drawing is prefixed to the treatise, showing a boat with chimney smoking, a pair of wheels rigged over each side of the stern. From the stern of the boat a tow line passes to the foremast of a two-decker, which the boat thus tows. This is evidently the first idea of a steam tow-boat. As this was a published treatise, and there was a patent on record, public information must have circulated of a steamboat before the experiments of Fitch or Fulton or Stevens or Livingston; and, while similarity of ideas in inventions is not infrequent, absolute originality is difficult to establish."

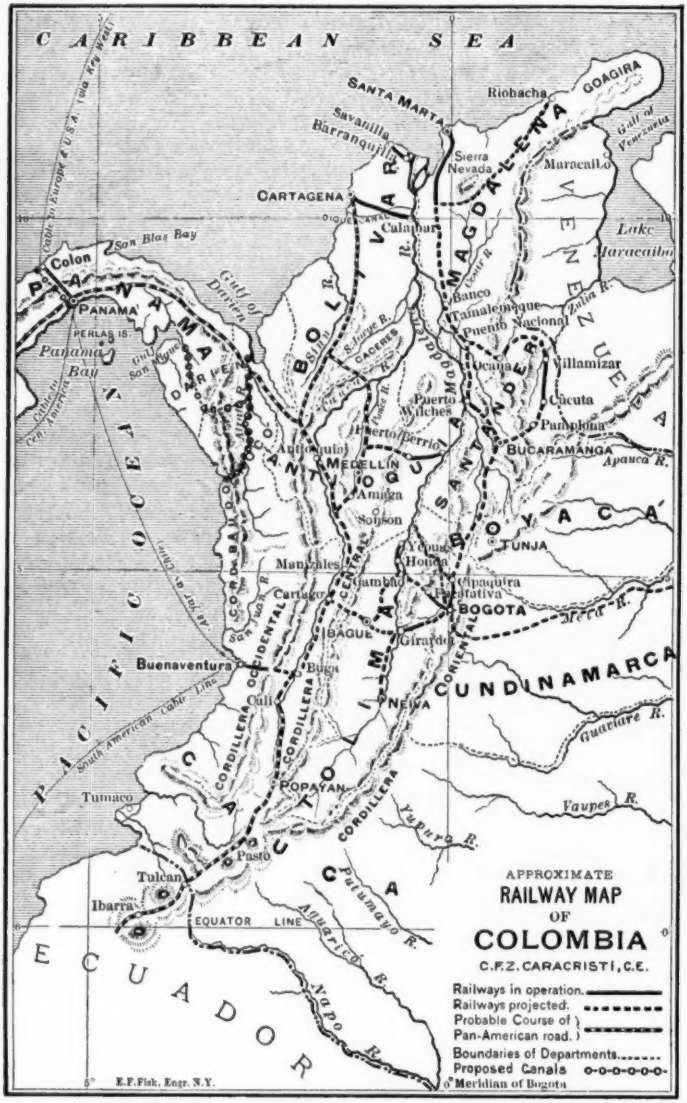
BUSINESS OPPORTUNITIES IN COLOMBIA.

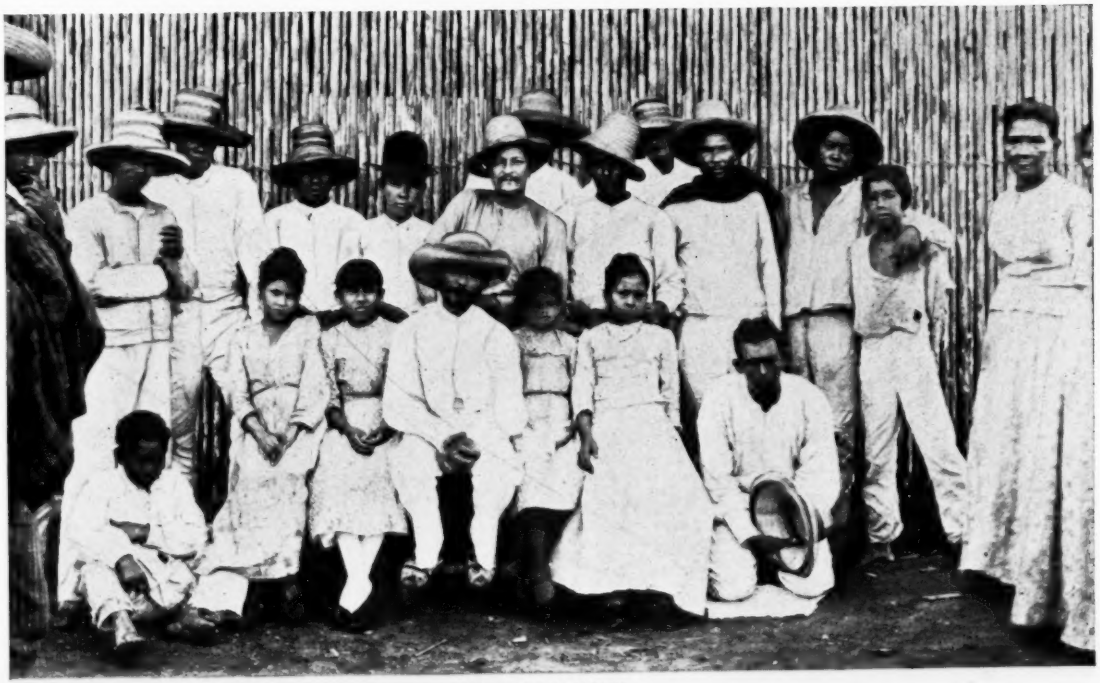
By C. F. Z. Caracristi.

CONTINENTAL Colombia is a great, a beautiful, and a promising country, little resembling the isthmus of Panama, as is often mistakenly supposed. The isthmus is only the poorer part of Colombia,—in fact, the worst. At Bogotá, Medellin, and other large cities of the interior are found the polish and refinement of Paris. French and English are spoken with remarkable fluency, and the Latin classics are well understood. With the better classes, and among the *peons* as well, hospitality is one of the principal traits, and that courtesy and hospitality of which our own Southern people boast is overshadowed by the Colombians' chivalry and consideration. With them it is not a virtue to be hospitable, but it is almost a crime to be otherwise.

It is a sad reflection that many of the Americans and Englishmen who have received concessions from Colombia have turned out to be mere idle adventurers, without moral or financial support, who have dragged the concessions from pillar to post in the hope of realizing a few dollars. These people, with no record at home, who in many cases had been abject failures in their own countries, have repeatedly snared the confiding Colombians into giving them valuable privileges, which were offered for sale here, there, and everywhere until they lapsed and died of their own gravity. If a peanut-vender or street-fakir should enter a banking house, trying to float a foreign loan, he would be summarily ejected ; yet people of this or similar character have gone to Colombia, secured concessions, and brought them back to our bankers. The consequence has been absolute failure to place the enterprises, many of which have had value, and, if presented by men of standing, would have resulted in large profits to both promoters and investors, and the advancement of the country's material welfare. President Caro is a man of sterling honesty and pronounced ability, whose aim is higher than mere office for power. He is a scholar of renown, and deserves the earnest support of all honest Colombians, regardless of their political views. One of his strongest advisers, and by far the most unassuming of them all, has been the Hon. Marco Fidel Saurez, secretary of foreign affairs, a man courteous in manner, considerate in sentiment, and of the highest order of intellectuality.

Colombia is a republic, composed of nine departments corresponding to States. It has a constitution, ratified in 1886, similar to that


CARIBBEAN SEA
SANTA MARTA
Riohacha
GOAGIRA
Savanilla
Barranquilla
Gulf of Venezuela
Sierra Nevada
Maracaibo
CARTAGENA
DIQUE CANAL
Calamar
Lake Maracaibo
San Blas Bay
Colon
PANAMA
Gulf of Darien
Banco
Tamalameque
Puerto Nacional
Zulia R.
PERLAS IS.
Panama Bay
Gulf San Miguel
Ocana
Villamizar
Cucuta
Puerto Wilches
Pamplona
Puerto Berrio
BUCARAMANGA
Apaura R.
Antioquia
MEDELLIN
Amiga
Sonson
TUNJA
Yepus
Honda
Manizales
Guambo
Tipaquira
Facatativa
Carthago
BOGOTA
Girardot
IBAGUE
Buenaventura
Buga
CUNDINAMARCA
Guatiquia R.
Cali
NEIVA
Tumaco
POPAYAN
Vaupes R.
Yuparo R.
Pasto
Tulcan
Ibarra
EQUATOR LINE
Putumayo R.
Aguarico R.
Napo R.
ECUADOR
APPROXIMATE
RAILWAY MAP
OF
COLOMBIA
C.F.Z. CARACRISTI, C.E.
Railways in operation.
Railways projected.
Probable Course of Pan-American road.
Boundaries of Departments.
Proposed Canals
Meridian of Bogota
E.F.Fisk, Engr. N.Y.



COLOMBIAN NATIVES.

ATLANTIC ENTRANCE, PANAMA CANAL.

of the United States, except in the provision that the departments shall be governed by the central government as in Switzerland. The executive power is vested in a president, a vice-president, and a *designado* who is second in succession after the president. The legislative branch consists of a house of representatives and a senate. The judiciary is composed of a supreme and lower courts.

Colombia occupies the very center of the western hemisphere, and its territory connects South and North America by the isthmus of Panama. It also holds a strategetic position of the greatest importance, and is the center of vast commerce. The country is very varied in climate, altitude, and productions. It has magnificent bays and harbors, navigable rivers, volcanoes and glaciers, high table lands and low lands, and produces almost every variety of flora known to botany. The area of the country is, according to its last boundary settlement with Venezuela and including its claims upon the Mosquito coast, over 600,000 sq. miles. The population is estimated at more than 4,000,000. Colombia is equal in size to New England, New York, New Jersey, Pennsylvania, Delaware, Maryland, Ohio, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, and Georgia.

Colombia produces gold in large quantities, silver, copper, iron, coal, cocoa, coffee, cocoanuts, bananas, skins and hides, cattle, dyewoods, india rubber, cabinet woods, emeralds, cotton, and tobacco.

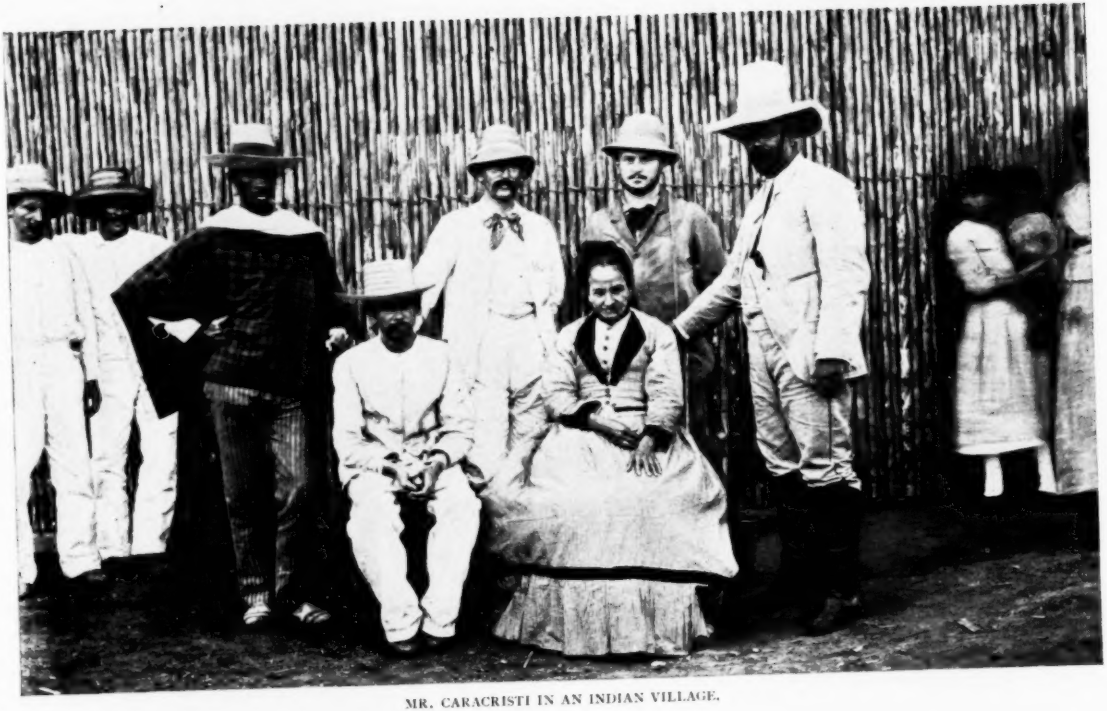
The most important mines so far discovered are the Sanncudo gold

mines of Antioquia, the emerald mines of Muso (Boyaca), from which the government derives a large annual income, and the salt mines of Cundinamarca (Zipaquira), which are also a government monopoly. To these latter mines the government has also reserved the coal fields situated on public lands. The petroleum fields cover an area of over 1200 miles, containing constantly flowing oil springs.

The climate of Colombia varies from the oppressive heat of the equatorial regions to the cold of the Antarctic in the glaciers. The heat is not so marked as it is in the United States during the summer months, and near the coast during the day the thermometer stands at from 76° to 89° F., seldom rising above 95° even on the hottest days. The nights are cool, and the sanitary condition of the lower country is about the same as that of lower Louisiana. In the hills and mountain valleys the climate is a perpetual spring, where malarial diseases and pestilences are unknown. The isthmus of Panama is very unhealthful; rain falls more or less every day. The climate of the isthmus is about the same as that of the regions crossed by the proposed Nicaragua canal and the Tehuantepec railroad.

The routes of transportation are principally the rivers. The Magdalena is navigable from Barranquilla to the lower falls at Yegues, a distance of 600 miles, and above the falls by steamer and small boats 150 miles farther. The Sinu, Atrato, and Cauca are also im-

THE CULEBRA CUT, PANAMA CANAL.



MR. CARACRISTI IN AN INDIAN VILLAGE.

portant rivers. The Orinoco, Meta, and Amazon are navigable in Colombian territory, but they traverse a perfectly wild territory, and only the Meta is navigated by steamboats.

From the last accurate statistics that I have been able to compile, I find that the country's imports reached $15,361,402 during the year while exports during the same period amounted to $24,138,-621 (Colombian currency). This shows a decline of more than $4,000,000 in imports, and an increase of more than $5,000,000 in exports, as compared with those of 1892. Evidently the decline in imports and increase in exports are due to abnormal conditions, the main ones being the high rates of exchange and the fact that the merchants are paying off in produce the old bills rather than purchasing new stock at ruinous prices. In 1892 the difference between American gold and Colombian paper was 81 per cent. in favor of gold, while to-day the premium on gold is 200 per cent.; that is, you can get three Colombian paper dollars for one gold dollar. With 81 per cent. premium on gold and goods sold on credit, there is a difference of $1.19 on every dollar of Colombian currency. For this reason the merchant has not been in a position to give new orders except for his actual current demand, but has been making heavy shipments of Colombian products to keep up payments. It must be added that

VILLAGE OF ARACATACA.

the Colombian merchant is honest and reliable, and that he will suffer almost any privation himself in order to meet his drafts and protect his commercial good name.

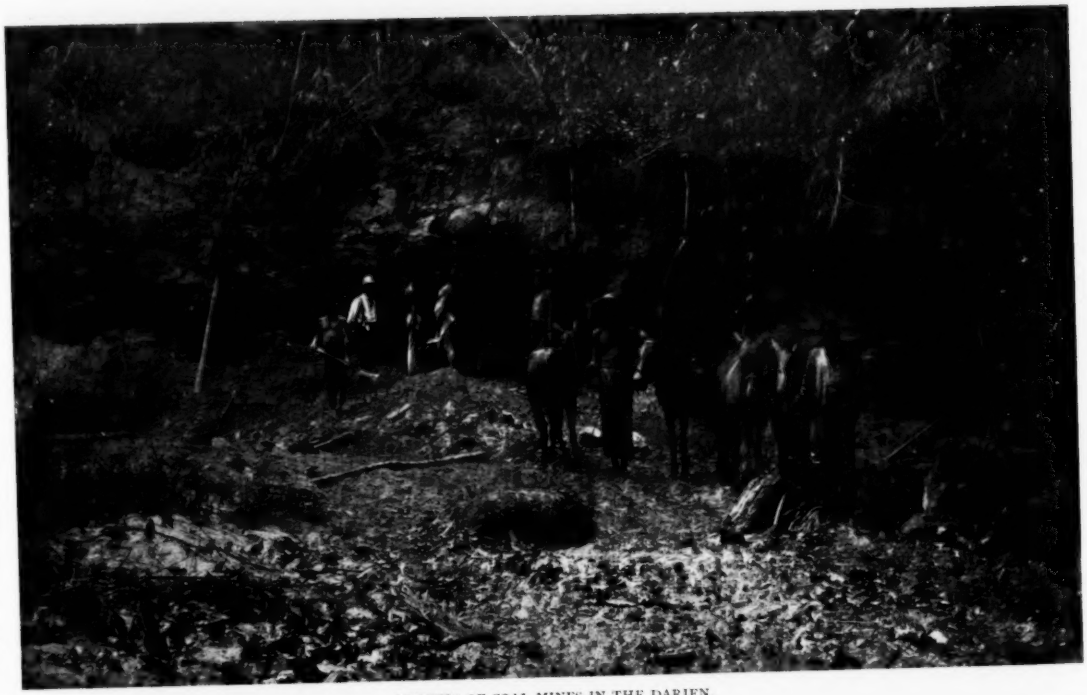
All of this commerce has been carried from the port of destination, from and to Colombia, by the use of 288 steamers and sailing ships, 41,000 *burros* (donkeys), 37 river steamboats, and 253½ miles of railroad. Twenty steamers touch regularly at Colombian ports each month. Of these six are under the United States flag, but they carry very little Colombian product, as they are used for the isthmus trade on the way to and from New York and San Francisco. Of course this trade, being only transient, is not accounted for in the statistics given here. Not one American steamer touches regularly at Colombian ports, except at Colon and Panama,—200 miles from the nearest continental Colombian port.

How should we account for this neglect on the part of our maritime interests? It is impossible to-day for an American passenger to reach either Cartagena, Barranquilla, or Santa Marta without sailing at least part of the way under a foreign flag. The Colombian trade is a paying trade; why should we not control it, in place of being satisfied with a little less than 11 per cent. of it?

As to railroads, the limited space at disposal prevents going into details here, and the reader must be referred to the careful and conservative review of the subject by Mr. Juan de la C. Posada ("The Railroad Development of Colombia"), in THE ENGINEERING MAGA-

NATIVE HUT, NEAR TURBO, GULF OF DARIEN.

MODES OF TRANSPORTATION.

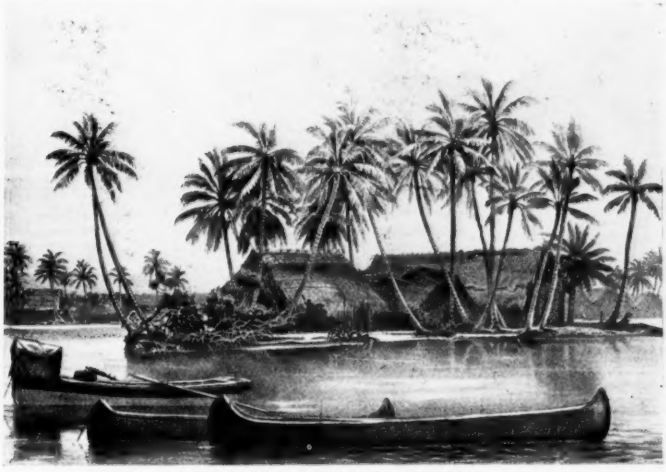


OPENING OF COAL MINES IN THE DARIEN.

ZINE for August, 1893. Since the date of Mr. Posada's paper, the situation has, of course, somewhat changed; some progress has been made, and the outlook generally is promising.

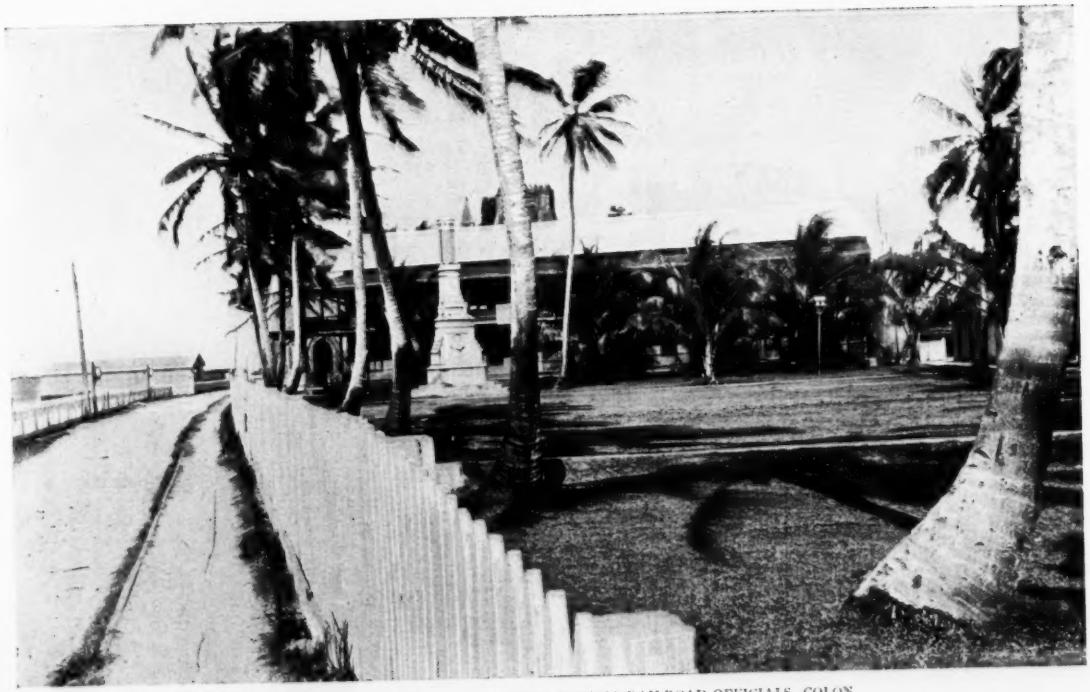
Mineral development in Colombia is still in its most primitive condition, and in gold mining the methods used by the Cuna and Chibcha Indians are still resorted to. My two years of continuous labor in making the surveys, reports, and maps of the coal deposits of Colombia have just been crowned by the active development of the great coal measures of that region. Next to the Chilian nitrate beds, these coal deposits are the most valuable mineral of South America. To the navy and merchant marine of the world they are of great importance, and to the commerce of South America they are the foundation from which must rise an industrial future, while to the Panama and Nicaragua canals they are only next in importance to water. No coal mines are operated at present in South and Central America, except some poor lignite mines in Argentina, against which the Welsh coal easily competes. No less than 3,000,000 tons of coal are imported into South and Central America, the West Indies, and Mexico, the cost of which ranges from $8 to $20 per ton.

In the first place I busied myself with the examination of the coal measures of the isthmus of Panama near the boundaries of Costa Rica. Here I found only worthless lignite. This was near Chiriqui, the point which was examined by the United States navy officers, and which is remembered in connection with the "Thompson scandal,"



INDIAN SETTLEMENT, BAY OF SAN BLAS.

"CHRISTOPHER COLON," FRENCH QUARTER OF THE PANAMA CANAL, COLON.



"WASHINGTON CLUB," HEADQUARTERS PANAMA RAILROAD OFFICIALS, COLON.

COL. REEVES' HOUSE, COLON.

during Hayes's administration. From the Atlantic coast I crossed over the isthmus to Gulfo Dulce and Gulfito on the Pacific, where in the mountains I found some good coal, but did not examine it thoroughly. This was in a tertiary formation, and was much dislocated by convulsions which had occurred at some remote period. Analyses showed 34 to 41 per cent. fixed carbon, 1 to 2 per cent. sulphur, and 7 to 12 per cent. ash.

I next undertook the exploration of the coal found in the wilderness extending from Cabo de Tiburon and along the shores of the Gulf of Darien or Uraba and the many rivers that empty into it; and from this point I explored the whole of Colombia to the northern extremity of the Goajira peninsula,—a total distance of 600 miles. In the valley of the Atrato river the coal measures are well defined, and anthracite, bituminous, and cannel coal are found in great quantities. I paid but little attention to the coal of this valley, except to examine it as to form, etc., because I supposed that coal could be found much nearer the shores of the Caribbean sea or on the Gulf of Darien itself. Such proved to be the case.

On the Rio Veraquarando I found, on the upper waters, beds of semi-bituminous coal that would make the heart of any miner throb with joy. Here the coal is compact, of bright color, and low in sulphur: and more than sixty veins are encountered in a distance of ten miles. Coming northward, I again passed numberless coal veins, but these, at places, were somewhat decomposed on the surface. I

had no way of mining; neither had I the time to do so; but what I did see on the surface convinced me that a large deposit of workable coal had been passed over.

On the banks of Rio Jobo, and also on those of Rio Punta de Piedra, about fifteen miles from the Rio Atrato on the eastern shores of the Gulf of Darien, the coal measures are again exposed, and, ascending the Rio Punta de Piedra about four miles, I found excellent beds of good, workable anthracite. Analysis gave 77.52 per cent. fixed carbon. The anthracite beds range from 3 to 12 ft. in thickness. The climate, a few miles above the exposed veins, is excellent.

After crossing many rivers and a series of *cienagas* (swamps), I arrived at the Rios San Juan, Jobo, and Arboletes, where I found a large number of beds of excellent bituminous coal. Three or four miles from the coast on the Rio Jobo I found one bed of bituminous coal of excellent quality, nearly 15 ft. thick. Next I examined the coal on the Sinu river and a vast deposit of cannel near the bay of Cispata. In these regions there are over eighty veins of cannel and semi-bituminous coal of the best quality. Analyses of this coal show it to be of high commercial value. From this point the measures were followed to the Sierra Nevada de Santa Marta, where cannel is found in large quantities.

Now that the world's petroleum supply has reached an alarming

COUNT DE LESSEPS' HOUSE, COLON.

MARKET ON THE MAGDALENA RIVER, BARRANQUILLA.

point of under-production as compared to the future visible demand, it may be interesting to learn that Colombia contains some of the finest oil fields ever discovered, and that, although there has been no publicity as to the working of these wonderful fields, yet it is a fact that they are to-day being developed with a view of eventually controlling the South and Central American markets. How far this work will progress, and what effect the Colombian supply will have on the oil markets of the world, remains to be seen.

My explorations began on the Rio Atrato and extended into the hills that face the eastern shores of the Gulf of Uraba. Over nearly all the territory I found more or less oil, but the best specimens were those obtained near anthracite and semi-anthracite coal. Much oil is found on the Caribbean near the port of Arboletes, the fields running from there in a northeasterly direction to the Magdalena river. From the first point where I found the oil, to Barranquilla, on the Magdalena, is a distance of more than 300 miles by a circuitous route. In connection with the oil, I also found a number of natural gas vents, the most important of which are near Turbaco, southwest of Cartagena, the capital of Bolivar. The strata carrying the petroleum are generally horizontal, and where they have a dip it is only about 12°. Most of the oil is high in naphtha.

Large deposits of asphaltum and ozocerite are found in the neighborhood of the oil, which in quantity and quality are equal to those of Trinidad. Tests made of Colombian asphaltum proved its practical value.

The valleys of Colombia abound in fossil resin, used often as amber. This is found in irregular pieces, from the size of a pea to that of a barrel. For the manufacture of shellac varnish the material is of the best quality, but thus far no practical use has been made of the product. An interesting feature of this product is that it is pine resin, but found in localities where it would be impossible for pines to grow now, owing to the great heat. From this it must be inferred that the resin was deposited there at a time extremely remote, when pines could grow in what is now an ultra-tropical region.

According to Rectrepo, nearly $1,000,000,000 worth of gold has been produced in Colombia since the time of the conquest. The present yearly shipments of gold and silver amount to about $1,000,000, mostly from the mines of Antioquia, Tolima, Cauca, and Santander. My own investigation of the subject has assured me that the greatest possible opportunity is offered in the gold, silver, and platinum fields of Colombia. During my explorations I have crossed hundreds of miles of alluvial deposits and innumerable veins of gold-bearing quartz. Many of these deposits would be extremely valuable in the hands of enterprising owners. As it is, they are almost unknown, while thousands of miners all over the world are idle. No better opportunity is available to young men of adventurous spirit, with a little money, than in the gold and silver mines of Colombia.

Large quantities of quicksilver are found in the lime formation of the central range of the Andes. There the deposits are of cinnabar;

PLAZA, BARRANQUILLA.

KING OF THE SAN BLAS INDIANS, SACEDI.

BOGOTA—PROCESSION DEL CORTUS.

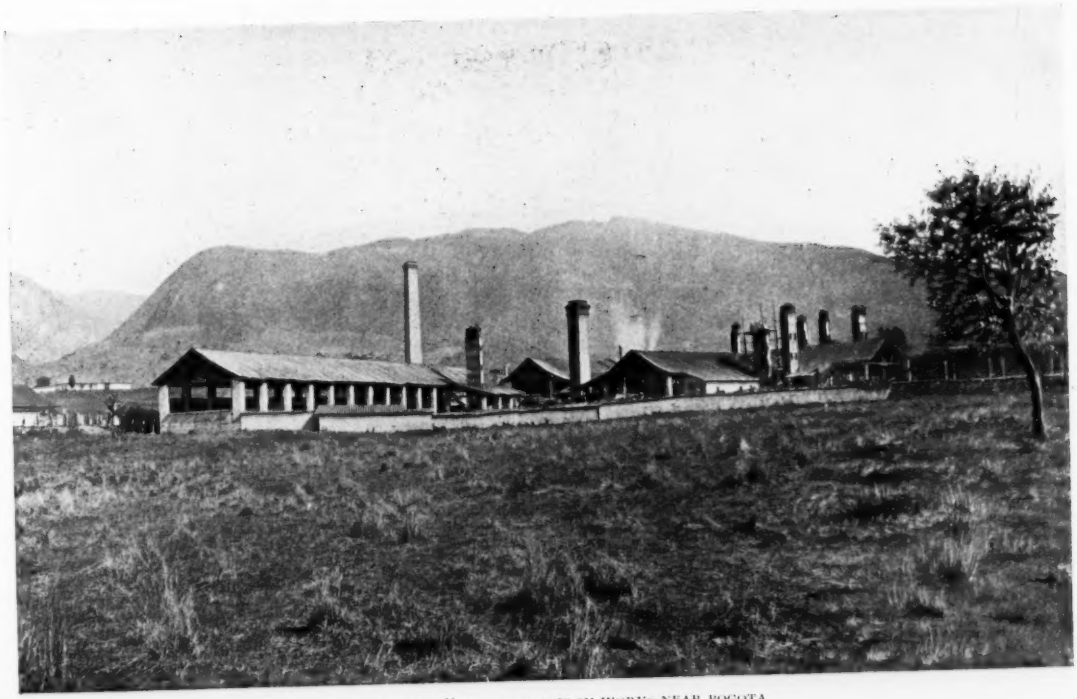
INTERIOR OF GENERAL POST OFFICE, BOGOTA.

while on the Atlantic coast native quicksilver is often found in a porous sandstone. This product, too, might and should be made the basis of serious and profitable operation.

Colombia abounds in the rarest varieties of marble and onyx. The white statuary marble of La Cienaga in the department of Magdalena has proved itself equal to that of Paros and Italy; and as the deposit, rising 1000 ft. above the sea level, is situated only two miles from the Caribbean, its commercial value should be seen at once, especially when we remember that the stone in the crude is worth $9 per cu. ft. The green, red, black, purple, and variegated marbles of the interior are some of the most beautiful I have ever seen. The onyx deposits, too, are extensive, and will be valuable whenever mediums of communication are established from the interior to the coast.

Gypsum beds extend along the coast for several hundred miles, and are of excellent quality, but so far no work has been done on them. The stratum is some 10 ft. thick and in many places translucent. This material, which is largely used in the manufacture of plaster of Paris and fertilizers, could be mined at about 50 cents per ton, and the freight to this country should be only an additional $1.75 per ton.

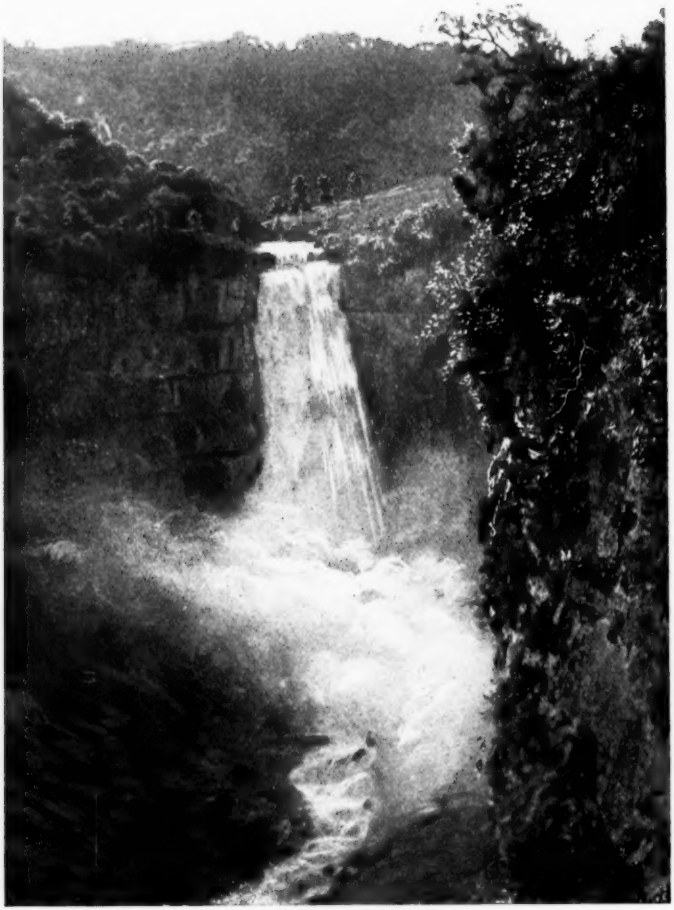
Phosphate of lime is found in large quantities on the Goajiran peninsula and at other places along the coast. These deposits in places



"LA PRADERA," THE GREAT IRON WORKS NEAR BOGOTA.

VIEW OF COUNTRY NEAR BOGOTA, 9500 FT. ABOVE THE OCEAN.

CAPITOL SQUARE, BOGOTA, COLOMBIA.



TAQENDAMA FALL, NEAR BOGOTA—A PLUNGE OF 700 FEET. INCLUDING THE RAPIDS ABOVE, ABOUT 95,000 H. P. AVAILABLE FOR ELECTRIC TRANSMISSION.

are very large, but, owing to the uncivilized condition and warlike proclivities of the Indians, were unknown until my exploration of the region.

Large quantities of copper ore are found back of Santa Marta and along the eastern range of the Andes. In the Sierra Nevada there are large veins of copper-bearing quartz, carrying a good percentage of silver and some gold. Why they have not been worked is a matter that I cannot understand, as they were known to the French through the able report of M. Fleury, who examined them some ten years ago.

Iron ore is found in large quantities in Colombia, and embraces all of the known varieties. Red and brown hematite are the most common, but good bessemer magnetite is found in many localities, especially in the Santa Marta mountains, where coal and limestone for flux are found in abundance. This is a healthy locality, where man can select his own most suitable climate, owing to the fact that from the low lands a series of table lands rise to a height of over 15,000 ft. above the sea level. At La Pradera in the department of Condinamarca the enterprising General Bariga has started and is operating an iron furnace and general iron works, which have cost over $1,000,000. The work done there is of the best quality and workmanship. The castings are perfect. The Colombian artisan is generally able and industrious in the mountain regions, where the heat is not oppressive, and General Bariga has now trained Colombians to do all his work.

Colombia abounds in large deposits of manganese ore, and at one place alone, near Puerto Bello, over 2,000,000 tons of the mineral has been measured up by Mr. Schablas, the superintendent of the Caribbean Mining Company, of Baltimore. This company has just completed a 14-mile railroad, connecting Vientos Frios with the mines. I learn that shipments of the ore are to be made at once.

Colombia will produce all of the known agricultural staples. All that is necessary is to rise into the mountains for a colder climate. Bananas, cacao, cocoanuts, coffee, wheat, rice, oats, potatoes, and, in fact, almost anything can be grown by choosing the proper altitude. Some of the banana, cocoanut, and coffee plantations are now actually paying an interest of from 40 to 85 per cent. on the original investment. No country affords a better opportunity to the ranchman or farmer willing and able to work than Colombia. What Colombia needs is a fresh start,—new blood and Anglo-Saxon energy and progress combined with modern methods and machinery; if she gets it, what is now a wilderness will become in a few years a smiling garden of wealth, prosperity, and industrial and social harmony.

THE MAGNETIC SEPARATION OF IRON-ORES.

By Clinton M. Ball.

IN many localities throughout the world magnetic iron-ore is found in large bodies, and in convenient proximity to other resources required for its conversion into commercial iron and steel. Many of these would have great commercial value if they were suitable for direct use in the operation of steel-making, on account of their nearness to the principal points of consumption. But most of these ores are associated with substances capable of entering into deleterious combinations with iron or its oxids, and thus are unfit for use in the production of the higher grades of finished metal. It is only since the development of the bessemer process that the art of the chemist has come to the aid of the manufacturer in the investigation of the causes and effects of the presence of these pernicious elements, the most common of which are phosphorus and sulphur, during the process of reduction. Generally, though not always, these elements are found existing in non-magnetic compounds,—a circumstance which has led to the expenditure of much time, money, and ingenuity in unsuccessful attempts to effectually separate the magnetic oxid of iron from crushed ore, and from sands, in which latter it occurs in great abundance in many parts of the world.

The enormous increase in annual consumption which has resulted from the cheapening of steel through improved processes of manufacture is forcing steel-makers to inquire whence are to be obtained the future supplies of bessemer ore to meet the ever-increasing demands of the trade,—a question only partially answered by the remarkable developments in recent years of the ore-ranges of the Lake Superior district. The future prosperity of American steel manufacture must depend largely upon the ability of our manufacturers to meet the world's lowest prices, and this in turn is dependent upon the certainty of an adequate supply of the raw material at prices at least but little in advance of those ruling at present.

The critical study of the conditions of economical production inevitably resulting from the industrial depression of recent years has led, among advanced furnace-managers, to a keen appreciation of the important advantages attending the use of the richer ores, in the way of improved quality, increased output, economy of fuel, and general reduction in cost per ton of product. This, in turn, has directed attention to the peculiar advantages possessed by properly-prepared magnetic concentrates, consisting, as they do, not alone in the low

percentage of deleterious impurities, but in what is no less important in steel-manufacture,—absolute uniformity in grade. Both the theoretical and practical importance of magnetic concentration as a factor in steel manufacture has been fully determined, and is now freely conceded; it only remains to ascertain to what extent the process is commercially feasible under existing competitive conditions.

The history of the art of magnetic concentration is largely one of sunken capital, abortive experiment, and unrealized expectations, and in the category of helpless failures must be counted some of the most ambitious and expensive undertakings of recent years. Without attempting to dwell upon these, it will be sufficient, in the present paper, to point out the road to successful practice, and to make brief reference to what has been actually accomplished.

In attacking the problem of ore-separation from its practical side, the first consideration must be that of the maximum possible efficiency of the method of separation proposed. In earlier days the experimenter, fascinated by the mysterious rush of ferruginous substances towards magnetic poles, hastily concluded that a powerful magnet,—and of course the more powerful the better,—combined with any crude apparatus for moving the ore into and the magnetic constituents out of its sphere of attraction, would fulfil every requirement of the problem. It was, moreover, assumed, with a confidence born of inexperience, that, in a finely-divided mixture of magnetic ore and non-magnetic gangue passing in a stream through a magnetic field, the former might be cleanly separated from the latter into "heads" of substantially pure magnetic oxid and "tails" of barren gangue, by a simple two-part division. Not until the history of hundreds of failures had been written into the archives of the patent-offices of America and Europe, did it, apparently, occur to any one that any virtue might be found in a specific and rational distribution of the lines of magnetic force with reference to the moving masses of pulverized ore; and even at the present time many persons representing large interests in iron-mining and metallurgical operations are apparently wedded to, and unable to see beyond, these fundamental fallacies of inexperience, and so, from a disastrous experience of unsuccess, rashly jump to the conclusion that magnetic separation, as a useful art, can have no existence.

In determining the efficiency of a proposed method of ore-separation, representative samples, produced under conditions of actual commercial performance, of the crude ore, the concentrate, and the tailings, should be obtained, and their respective percentages of magnetic and non-magnetic constituents accurately ascertained. The efficiency and practical value of any system may then be ascertained by the application of simple formulæ. In order to satisfactorily meet the conditions

of transportation and use, a concentrate should have the coarsest possible granulation combined with the highest attainable purity, the respective percentages of sulphur and phosphorus, being brought at the same time, if possible, within bessemer limits. Chemically pure magnetic oxid corresponds to the formula $Fe_3 O_4$, or 72.42 per cent. of iron and 27.58 per cent. of oxygen. Crystals of this oxid obtained from different mines will vary widely in size, but those from each individual mine are likely to present a general uniformity in character and dimensions. The general average of such ores may be taken to consist of about equal parts of magnetite and gangue. In the concentration of such ores, if the percentage of magnetite be raised to 90, with 4.5 per cent. of magnetite left in the tailings (corresponding to 65.18 per cent. of iron in the concentrate and 3.26 per cent. of iron in the tailings), the result may be looked upon as satisfactory, inasmuch as this standard in the concentrate will usually reduce the proportion of phosphorus and sulphur within the required limit.

In this case it requires 1.879 crude units to make 1 concentrate unit, and 95.79 per cent. of the magnetite in the crude ore is saved in the concentrate, while 4.21 per cent. is lost in the tailings; the actual efficiency of the operation of separation will, therefore, reach nearly 96 per cent.

It might seem at first sight as if such a result as that above indicated might be realized by any well-constructed separator, irrespective of its particular type, provided sufficient magnetic force were present to prevent the escape of magnetic particles into the tailings. But the result in reality involves a more complex series of operations than would at first appear. The concentrate ought to be as coarse as possible, not only for technical reasons already stated, but because of the enhanced cost entailed by unnecessarily fine crushing,—a cost which in some instances might easily make all the difference between commercial success and commercial failure. Moreover, a sound theory of ore-separation dictates that in the initial stages of the process the operation of crushing should be carried only just far enough to cause the product to correspond in the average dimensions of its fragments with those of the pure magnetite. A mass of ore in this condition will contain pieces of pure magnetite, others of pure gangue, and still others of a complex character,—part magnetite and part gangue, —the latter constituting perhaps 10 per cent. of the whole. It is obviously desirable that, when in this stage, the three grades of material should be separated before going further, inasmuch as the pure magnetite would require no further treatment, and the pure gangue might be rejected as tailings, thus at once completing the treatment of at least nine-tenths of the whole mass. On the other hand, the composite

portion of the material, if permitted to pass into the concentrate, would carry all its impurities with it, and at the same time lower the percentage of iron in the product, but, if thrown away with the gangue, would involve an inadmissible waste of valuable material. This intermediate portion, therefore, should be re-crushed to a fineness sufficient to liberate substantially all the magnetite from its adherent gangue, and afterwards re-separated, after which the respective products of re-separation may be added to the concentrate and tailings of the preliminary separation. It will be obvious that the "middlings" resulting from the preliminary separation must closely correspond in grade to the average of the crude ore, and that but a comparatively trifling expense need be involved in the reduction and re-separation of so small a proportion of the original mass. The great importance of this three-part method of treatment may be demonstrated by an analysis, which need not be given here, the results of which show that, if the middlings should be added to the concentrate, instead of being re-crushed and re-separated, the product would consist of 57.9 per cent. of concentrate and 42.1 per cent. of tailings; while, on the other hand, if the middlings should be thrown out, the product would consist of 47.9 per cent. of concentrate and 52.1 per cent. of tailings.

Even the apparently small difference between two concentrates, one containing 60 per cent. and the other 65 per cent. of iron, is really of very great importance, for, while the latter would contain only 10 lbs. of gangue in each 100 of concentrate, the latter would contain nearly 17 lbs., and would usually carry with it such an amount of sulphur and phosphorus as to render it wholly useless for bessemer requirements. Moreover, experience has demonstrated that a difference of no more than five units of iron in each hundred, in the charge of a blast furnace, may make a difference of as much as 20 per cent. in its effective output.

In view of the above considerations, it is not difficult to understand the reasons underlying the disastrous commercial results of attempts at two-part separation by magnetism, as well as by water-jigging and other analogous methods, or why the successful practice of the art has so long been compelled to await the advent of a separator constructed in accordance with scientific principles.

It will readily be understood, after what has been said, that the successful carrying-out of the three-part process of separation above outlined must require an apparatus capable of working with great precision. Such an apparatus must discriminate accurately between the different grades of material, must make a clean selection of magnetic from non-magnetic material, and, among particles of mixed material of varying degree of purity and magnetic susceptibility, must differentiate

the middlings from the pure magnetite. All this, however, has been successfully accomplished by some of the recent machines.

It is unnecessary in an article like this to enter into a minute technical description of the construction and mode of operation of such an apparatus. For the present purpose it is sufficient to say that the machine comprises, first, a stationary range of magnetic poles, alternately of unlike polarity in the direction of the ore-travel, underneath which the drums, enclosing the two groups into which the range of poles is divided, serve as rotating carriers of the granulated ore, the ferruginous particles being sustained upon the under-surface of the drums by magnetic attraction; second, of means for applying a strong counter-current of air to the moving mass of ore while passing through the machine; and, third, a differential speed of rotation of the respective drums, assisted by a relative adjustment of the magnetic strength of the two groups of poles for the purpose of differentiating the ore under treatment into the grades which have been referred to. In this type of machine provision was for the first time made for the coöperative and interdependent functions which render the three-part process of separation a commercial possibility. The most characteristic and essential feature in the mode of operation of such a separator consists in the tumbling or shaking of the magnetic fragments while suspended upon the under-side of the rotating drums, which results from their conveyance through a series of successive magnetic fields of alternating polarity. The multitudinous conceptions embodied in the machines of prior inventors, however varied in other particulars, were alike in this,—that they one and all presented a field of unchanging polarity to the stream of moving ore in the direction of its motion; hence there could be no possibility of further separation after the mass had once attached itself to the carrier. It will be readily apparent that such machines were fundamentally defective in principle. On the other hand, when a mass of granulated ore consisting of mingled magnetite and gangue is brought within the influence of two unlike magnetic poles, the particles form themselves into chains or loops, extending coincidently with the lines of magnetic force, from one pole to the other. The impounded fragments of gangue can be extricated from these loops only by breaking up their formation, while at the same time an adequate force is acting to remove the particles as soon as they are released. Such a breaking up of the loops is effected by causing them to pass into a field of reverse polarity, and meanwhile centrifugal force, gravity, and the counter-current of air are acting conjunctively to withdraw from the magnetic field the non-magnetic particles of gangue. In practice it has been found that the mere adjustment of the attractive force of the second group of magnetic poles is quite sufficient to ensure the com-

plete separation of the middlings from the pure magnetite. This may be done, too, with any desired degree of precision ; for example, particles consisting of five-eighths magnetite and three-eighths gangue may be retained in the concentrate, while particles containing a larger proportion of gangue will pass into the middlings, and so of any other proportion required. The importance of this feature in practical work need not be dwelt upon.

Fabulous sums have been and are now being wasted in mining, transporting, and smelting slag-making rock. A modern furnace costs far more than a separating plant of the type which has been described, not only in the original outlay for construction, but in expense of operation, while it cannot handle or dispose of anything like an equal quantity of raw material. The gangue or slag-producing substance, if permitted to go into the stack, must be transported, handled, melted, fluxed, and otherwise disposed of, at no inconsiderable expense, while, if carried direct to the separator, this useless rubbish is left on the tailings dump at the mine, and once for all got rid of at a comparatively trifling cost. A 50 per cent. ore has, until recent times, been regarded as a good grade of crude. It is a good-sized furnace that, working upon such an ore, can make an output of 100 tons of pig per day, and the expense of its operation is very great. A single separator of the type indicated will easily handle from 16 to 25 tons per hour of crude ore, and produce from 8 to 16 tons of 65 per cent. concentrate, the amount depending upon its granular condition and its richness. This quantity of concentrate would enable such a furnace to increase its output from 100 to 165 tons per day, so that one furnace and a separator would actually have nearly the productive capacity of two furnaces of the same size without the separator, while the comparative cost, both of construction and of operation, would be immensely in favor of the former organization.

Uniformity in the grade of the concentrate is the necessary result of the normal operation of the separator, and this results in uniformity of quality in the product of the furnace,—a matter of the utmost importance in steel-making, for, while it is true that large supplies of rich ores may be obtained from Lake Superior mines and other sources, these do not run uniform, either in grade or purity. In fact, considerable variation in percentages of objectionable impurities are not infrequently found in successive lots from the same mine. On the other hand, a magnetic concentrate from any given mine will always run practically uniform, however great the variations in the crude ore from which it is extracted, while its richness will fully equal that of the very best of native ores. The separator, therefore, must prove an invaluable auxiliary in aiding the manufacture of better and cheaper iron.

Since the year 1888 many plants for crushing and separating ore have been projected, and a considerable number have been erected and put in actual operation. Among the first plants in point of time, and absolutely first in technical and commercial success of operation, was that of the Magnetic Iron Ore Company at Benson Mines (formerly known as Little River), St. Lawrence County, N. Y. At that place, for the first time in the history of the art, magnetic separation was successfully prosecuted on a commercial scale, in the treatment of a low-grade, non-bessemer ore, to eliminate deleterious impurities and render it fit for steel-making. Prior to the date mentioned, the Magnetic Iron Ore Company had expended a large sum in building a railroad to Jayville, N. Y., developing the mines at that place and securing other property at Little River, before it was determined that natural ore of good quality was not to be found in paying quantities. The only way of saving this large investment was the establishment of a large concentrating plant at Little River - now Benson Mines—and the extension of the railroad to that point, near which exists one of the largest deposits of low-grade magnetite known in the United States. The ore has a dense, fine-grained structure, averaging about 45.5 per cent. of magnetite and 32.95 per cent. of metallic iron; and the crystals of magnetite, which approximate 1-16″ in average dimensions, are found associated with small crystals of apatite and pyrites. These peculiar characteristics of the crude ore render the process of milling and concentration, both from a technical and commercial point of view, a most difficult one. In order to be marketable, the ore must all be concentrated, while, to reduce the sulphur and phosphorus to steel-making requirements, the iron must be raised in the concentrate to run about 64 per cent., or to carry say 88.5 per cent. of magnetite and not more than 11.5 per cent. of gangue, and this must be done without involving an uncommercial loss of iron in the tailings. The problem was, however, satisfactorily solved by the application of the principles laid down in the present paper, the machinery having been put in successful operation in 1889. The plant, after having been greatly enlarged the following year, was maintained in nearly continuous operation until the great depression in the iron industry began in the summer of 1893. When in full operation, the works have a capacity of 1000 tons of crude ore per day of 24 hours, yielding about 500 tons of concentrate, the average character of the product being as follows:

	Magnetite.	Metallic iron.	Sulphur.	Phosphorus.
Crude ore,	45.5 per cent.	32.95 per cent.	1.00 per cent.	0.15 per cent.
Concentrate,	88.5 "	64.09 "	0.21 "	0.032 "
Tailings,	4.0 "	2.90 "		

Thus 95.53 per cent. of the magnetite in the crude ore is saved in the concentrate, and 4.47 per cent. lost in tailings, demonstrating the possibility of the conversion of a low-grade non-bessemer into a high-grade bessemer ore, and showing an efficiency of no less than 95.53 per cent. in commercial operation on a large scale.

Following closely upon the operations at Benson mines, a considerable revival of interest in the subject of magnetic separation was developed, and a number of plants were projected and erected in different places. At Mineville, N. Y., a series of elaborate and costly experiments and tests of separators of various types was carried out during the years 1889–92, which ultimately resulted in the adoption of the process above described. A similar result ultimately followed an attempt to work the two-part process at Bechtelsville, Pa., in 1889, which was definitely abandoned as unsuccessful, and was succeeded by the present profitable plant at Rittenhouse Gap. The Tennessee Coal, Iron, and Railroad Company is at the present time prosecuting at Bessemer, Ala., a series of most important tests, looking to the concentration of red, fossiliferous ore by first roasting to render the ore magnetic, and then concentrating with the magnetic separator; the outcome will be watched with great interest by Southern iron-masters.

The magnetites of the Champlain-Adirondack region yield exceptionally favorable results under this process, by reason of the facility with which they may be crushed and prepared for separation, and the purity and unusually coarse grain of the product. A typical example may be cited from the results of the treatment of ore from the new bed of Witherbee, Sherman & Co., of Mineville, N. Y., the preliminary crushing being carried to 1-6″.

	Magnetite.	Metallic iron.	Phosphorus.
Crude ore,	66. per cent.	47.8 per cent.	0.07 per cent.
Concentrate,	94. "	68.075 "	0.0123 "
Tailings,	8. "	5.79 "	

In this case 96.03 per cent. of magnetite in crude is saved in the concentrate, and only 3.97 per cent. is lost in tailings.

The increase in furnace capacity and improvement in quality of product resulting from the use of richer raw-material in the form of uniform high-grade concentrate is scarcely less important to the manufacturers of foundry pig-iron than to steel-makers, and, since results corresponding to those which have been cited may be obtained wherever similar ores exist, we may expect that, with the advent of increasing activity in the iron and steel industry, separated magnetic ore will ultimately fill a most important place in the supply of raw material for this most important industry.

PRODUCTION UP TO THE POWER LIMIT.

By Horace L. Arnold.

SUPPOSING a machine shop to have the best plant procurable, which means a large investment in lathes, planers, slotting, shaping, and milling machines, and quite commonly, now that the day of the general machine shop is passing, and almost every establishment, large or small, has its special line of production, a considerable number of machines especially adapted to the shop's individual requirements; supposing also, that this plant of carefully-constructed machines is put into the hands of a superintendent who fully understands that he, and he alone, must make the concern a commercial success,—under these conditions what should be the policy of the superintendent regarding the use of his fine and costly machine tools?

Shall he regard them with that pride, and affection even, which a really fine machine tool inspires in the appreciative mechanic, and, so regarding them, shall he use them carefully, taxing their productive powers well within the endurance limit, and having their preservation and long life always in mind? Or shall he regard them as merely a means to an end, to be used to their utmost power limit, regardless of the effect upon their nicely-fitted organizations?

At first sight it would seem that the most successful machine-shop superintendent must assuredly be the one most careful to have his machine tools, which perform nearly all of his work, in the most perfect order, so that every operation should be made with a certainty of accurate results. It is perfectly well known that machines have their limit of endurance; the front journal of a lathe spindle, for instance, may be run for many years by a careful lathesman with so little detriment as to remain during all that time in nearly as perfect condition as when it left its maker's hands. Or this front lathe-spindle journal may be overloaded with heavy weights on the face plate, or heavy cuts on light pieces of face-plate work, so that the boxes and spindle both show wear in a very short time. A lathe spindle which once shows faulty running is very seldom put exactly right again; it may be helped, but it is not often made as good as it was at first. Shall the superintendent of the fine equipment permit men running tools to drive them hard, and so risk the destruction of their accuracy of fitting?

On the other hand, regarding his splendid array of machines as mere aids to a desired result, shall he seek the speedy accomplishment of that result, regardless of the effect of haste on the instruments used? Shall every machine, every lathe, every planer, every shaper and driller

and milling machine, be driven up to the limit of the belt pull? Shall every tap, broach, and reamer be urged to the nearest possible approach to breaking strain, if the muscle of the workman can force it so far?

Certainly the commercially successful machine-shop superintendent can in no case permit obvious abuse of his machine tools; for example, he could not permit a planer table to be used as an anvil for straightening heavy pieces, nor would he allow the use of a sledge in adjusting face-plate work on a small lathe; such practices would destroy his plant at once, and could not be tolerated. But it is very evident that, when the question takes a slightly differing degree, there may be two sides to it.

Suppose a shafting lathe can finish 200 ft. of shafting a day for 20 years before it needs a rebuild; suppose, also, that it has power enough to turn 400 ft. of shafting per day, if urged to its utmost; in this case, if the lathe would run 10 years on the 400-ft. daily production, it would give the same total production as if its life had been prolonged to 20 years by easy usage.

But, when we consider the commercial side of this shafting lathe performance, it is at once seen that, while the total output of work is the same in each case, the work done by the carefully-used and long-lived tool has cost twice as much in wages, twice as much in insurance, floor-room, and all fixed charges, as the lathe driven to the limit, and worn out in half the time. Hence it is clear that in all cases the careful use of any plant must make the product more costly than if the plant were urged to its full capacity; and it is evidently not absurd to say that machine tools may be used with such care for their preservation that they fail wholly in the original object of their creation; they are never money-makers; their production is never great enough to warrant their existence; and the shop carefully managed to this unprofitable extent must go out of business, and cease to exist, simply and solely because of the anxiety of its superintendent or manager to prolong the life of its machine tools.

Machine tools are invariably, or almost invariably, used in conjunction with the labor of workmen. There are some automatic machine tools in use, as, for instance, some screw machines now in operation at Windsor Locks, in Connecticut, which are run by water power, and can be, and are, safely locked up and left to themselves for a week's run without attendance of any kind. But, speaking generally, machine tools are used with workmen, and with workmen who are paid more than medium wage.

Suppose a small lathe cost $500, and lasts 10 years. With money at 5 per cent. the yearly cost of this tool is $75 for the bare machine itself. It may occupy a floor-space of greatly varying rent value; per-

haps as little as $15 yearly. The labor figures are much larger; the lathe hand may be paid $1.50 per day, or $2.00, or even $3.00. If his pay is $2.00 per day, it is $600 for 300 days, or a year of working time; then for 10 years of lathe work as specified the shop pays $500 for the lathe, $250 interest, and $150 rent, and perhaps another $100 or so for other fixed charges, or say $1000 for the 10 years' life of the $500 lathe. But in the same time the shop has paid out $6000, or six times the machine-tool outlay, for labor to operate the tool. The total expense for the 10 years of assumed lathe life and use is $7000, of which only $1000 is chargable to the machine-tool account. Suppose now that, by driving this same lathe to the utmost limit of its belt pull, it had been forced to double its output, and had lived for only 5 years of service. This gives the same total product as before, at a machine-tool, rent, and interest cost of only $750, and a labor cost of $3000, making a total of only $3750 paid for the work as against $7000 paid for the work of the same tool with double the life; hence the profit on the output might be very great if the machine tool were destroyed quickly, as against nothing at all if the lathe were worked at an easy rate.

This simple example makes it very clear that accuracy, finish, close fitting, and easy handling,—the distinguishing points of our American machine-tool production,—are not enough in themselves to insure the commercial success of the users of such tools. To these most desirable American features the commercially successful machine tool must add a great metal-removing capacity; the greater the better, unreservedly. Hence the constant additions to weights of our machine tools for equal capacities, and the equally steady increase in the driving power given to tools of nominally the same sizes. Hence, too, good practice clearly demands the prompt retirement of such machine tools as are incapable of comparatively large production. They may be still in good condition, of respectable ancestry, stamped with names of which every American mechanic must always be proud, names of machine-tool builders who were leaders in their day; and yet these prides of the past should not be kept in use, and cannot be kept in use by any concern intelligently seeking commercial success.

Shall the superintendent, then, discard at once all reverence and sympathy for his machinery, and drive every tool in his charge to its utmost limit of production as fixed by the width and speed of its driving belt?

Shall he regard a planer, for instance, as an instrument by which a certain number of cubic inches of metal may be cut into chips, and make it cut that amount of metal and fit itself for the scrap heap in the shortest possible time? Assuredly yes, if the use of that planer is to make money.

The cost of labor is so very great in proportion to machine-tool cost in all machine-shop operations that the life of the machine tool is not an element to be considered at all. With the larger and more expensive class of lathes, planers, and machine tools generally, there is no danger at all of injury through over-driving. They are too large and have resisting surfaces of too great an extent to be injured by any effort of the workman's strength, or by the use of their own driving power along intended lines. They may possibly suffer through accident, very seldom indeed through over-driving.

The visitor who enters the Baldwin locomotive shops for the first time is at once impressed by the lavish supply of cranes in every department of those vast works. His next impression, if he be familiar with machine-shop interiors, is one of surprise at the remarkable diligence of the workmen; finally, as he becomes sufficiently familiar with his surroundings to notice details, he observes that very unusually large cuts are being taken in all places where there is a large cut of stock to be removed, and, when he turns his attention to details performed by hand, he sees the same extraordinary effect, gained in many cases by what would be considered in many shops a very uneconomical urging of the hand tools.

The shops themselves, as is well known, cover several squares in the vicinity of Fifteenth and Buttonwood streets in Philadelphia. They can use five thousand five hundred men, are the largest in the world in their line, and pay the highest wage given anywhere in the world to men in similar lines of employment; and the visitor familiar with the metal-working arts is very speedily led to the conclusion that, notwithstanding this high wage, the work is done very cheaply indeed, and in many cases at incredibly low prices.

Thus a pair of locomotive side frames 20 ft. long $\times$ 27 in. greatest width $\times$ 4 in. thick are surfaced on both sides accurately to thickness, and the straight side squared, in 8 hours. The price paid for this planing seems wonderfully low, as indeed it is; not only low, but so incredibly small as to make such a performance of deep interest to every superintendent and shop-owner.

The planer used for side frames in the Baldwin shops is a Sellers, with a very low housing and small cross rail in proportion to the table width and length. The cross rail is fitted with two saddles and tool posts; the drive is, of course, the well-known Sellers rack and screw, and handles very easily and promptly; this ready handling is an essential feature in the operation, as the machine reversing gear is not much used in planing side frames. The frames are put down with the horns of both heads towards the workman, and the two are placed so that the ends are even square across the table; the two tools in the two

tool posts are set so that one just touches the far straight top line of each frame ; then the tools are moved together over to the front side of the jobs, next to the workman, who starts the cut on the extreme ends of the horns of the driving box seat nearest to him, with $\frac{1}{4}''$ feed for the first roughing cut ; with the tools and frames set as described, whatever is done to the first frame is also done to the second one, and so the man has only one frame to watch as he sits in front and ships by hand, and ships very closely indeed, losing only a very small table travel on each end of each cut. The forgings are not at all close, there being as much as $\frac{7}{16}$ or $\frac{1}{2}''$ to carve off in some places, thus making quite a stiff cut, $\frac{1}{4}'' \times \frac{1}{2}''$, on the two frames taken together $= \frac{1}{2}'' \times \frac{1}{2}''$ section of metal removed at once. The planer is amply powered, however, and does not notice the work at all. The finishing cut with the flat nose tool is made with $\frac{3}{4}''$ feed, and does not take long. The roughing tool is what they term the "Oyster Shell" tool, with a rounded nose, and has an average of 12 or 15 degrees slope both ways, the point leading the top of the cutting edge. The side and bottom tool clearance angles are very small, perhaps not more than 3 degrees. Every hand grinds his own tools, and hence the cleavage and clearance angles vary considerably; but the "Oyster Shell" form, as it is called, —a name not used elsewhere, so far as known,—is the standard roughing tool for heavy cuts. Some of the tools were self-hardening or musket steel, and some were of well-known brands of tool steel.

It will be observed that the practice in these shops in regard to metal-cutting tools is not in the line of absolute uniformity ; various steels are used, and individual tool grinding on large wet stones and on emery grinders is the rule, instead of having all tools forged from one steel and ground by one man in the tool-room, which is the more generally approved course. Nor are air hoists used. The shops are, however, most liberally supplied with cranes and travelling hoists of other kinds. The very great use of air hoists in many other large establishments makes its exclusion from the Baldwin shops noticeable.

After the second side of the pair of side frames has been finished with the flat nose tool, $\frac{3}{4}''$ feed, the top lines are squared down, and the whole job finished in the time named,—8 hours. This job might easily take 3 days in a shop with ordinary planers and planer hands, and the rapidity of its execution is only a fair sample of the swiftness with which both tool and hand operations are carried on. The tools are driven to the power limit in all cases, the machine feeds not being put on when feeding by hand can hurry the work, which is thus made very severe on the driving gear. Various makes of tools are used, *only one or two well-known names of tool-building firms being made conspicuous by their absence, their product probably not being*

considered stiff enough or sufficiently powered to meet the output requirements.

Milling and planing operations are mixed, many cuts being partly planed and partly milled, and some of the milling machines are very plainly over-powered and under-framed, and generally wanting in diameter and support in their smaller parts,—hand wheels, feed screws, and so on,—the "limit drive" hunting out and exposing every weak point of their construction. It seems strange indeed to eyes accustomed to New England shops to see fine and unsuitably delicate machines driven to their utmost belt pull in a manner that will certainly put them in the scrap heap very promptly; but they are held to fully earn their money by great and rapid production.

Summed up in few words, the Baldwin shops' theory appears to the writer to be this: Every machine tool has, when new, a fixed metal-removing potentiality, and can cut a certain number of cubic inches of iron or steel or brass into chips before it is worn out; and the sooner it can be forced to cut those chips, the sooner it has reached the end of its total earning powers, and the sooner it has brought in its profits.

Perhaps a still broader view of the situation would justify the formulation of this policy in square foot of shop floor-surface terms; a locomotive building shop may be said to have a locomotive production of so much per square foot, per day or year, and any policy which will increase the square-foot production must certainly increase the profits arising from its use.

Either of these supposititious statements involves a policy which leads to the speediest possible wearing out of every machine tool in the plant as a needful step in economical machine production.

So far as the machine tools alone are concerned, it is easy to drive them to the limit of belt power. They are dead,—without will or volition,—and work to the limit of their capacity without protest of any sort. But machine tools require human attendance, and no means has yet been devised for producing workmen without decided ideas as to the extent, scope, and limit of their individual muscular efforts. The workman in general may be said to mentally decide upon the fit limit of his own labor, and many superintendents have found it very difficult to induce men to extend and enlarge their ideas in this particular. Indeed, workmen in general very promptly resent any attempt to make a day's work greater than they have mentally decided it should be. Briefly, again, it is easy to drive machine tools, but how shall machine-tool tenders, the lathe and planer and milling machine hands, be themselves driven to drive the machine tools to the limit of the belt pull?

The Baldwin workmen do drive themselves, or allow themselves to be driven. The visitor sees that at the first glance. Purely hand operations involving the use of purely muscular power are urged and driven and rushed to the limit of the workmen's strength, precisely as the tools are driven to the limit of their powers.

For instance, a workman in the act of reaming a bolt hole in the coupling flanges of a pair of locomotive cylinders with a fluted reamer $1\frac{1}{4}''$ diameter first drives the reamer, taper $\frac{1}{16}''$ to the foot, into the drilled hole in the flanges with heavy blows of a hand hammer, until the reamer is as far in the hole as it needs to go. Then, with an open end wrench 36" radius, he turns the reamer once round in the hole, using great muscular effort in so doing. All of this practice is out of the common. Fluted reamers are delicate and expensive tools, and the production of a smooth, true, perfectly-tapered hole is commonly held to require some skill and a good deal of care, and a distinct regard for the preservation of the reamer; and in many shops of high repute no workman would be permitted to drive a taper reamer as described, or to finish a taper hole by turning a fluted reamer once round in it. It probably would be difficult to find a workman in, say, the Pratt & Whitney or Bement & Miles shops who would use either the reamer or himself as described, of his own free will, or to please any one in authority. Yet in the Baldwin shops such violent muscular exertion is not the exception, but the rule, and the men are all perfectly contented, ready, and, if their appearance signifies, willing and eager to drive themselves and every tool put into their hands to the extreme limit of their powers of continued effort. How is this willingness of the men to work hard secured?

In the first place, every operation has its piece price, paid directly to the workman. In many New England shops certain of the workmen known as contractors take the production of an entire piece or machine at a fixed price, hire their own workmen, usually at day wage, and depend on their own push and knowledge of every step in the manufacture to produce the job at a cost, to themselves, as much as possible below the contract price which the firm pays the contractor for the finished article. This method may, and in most cases does, result in surprisingly cheap production, and in very substantial profits to the contractor, in which the workmen do not share at all. The workmen are docile; the contractor is intimately acquainted with the capabilities of each, and furnishes brains and push for all; and, as he has the power to hire and discharge his men, his authority is unquestioned, but seldom exercised, as the successful contractor is always in sympathetic touch with his hands. In the Baldwin shops there are no contractors, and the foremen have no possible way of increasing their salaries be-

yond their day pay; the piece price is paid directly to the workmen, who are thus enabled to make extra exertions bring extra money.

But even in this case workmen often decline to exert themselves, and refuse to overstep certain established lines of shop etiquette. Not long ago it was common for a machinist to refuse point-blank to keep two planers or two lathes running at the same time: this step in rapid production is now generally conceded, and it is commonly the rule for a man to run as many tools as he can well attend, and sometimes more. But workmen are not yet all of them ready to "make horses of themselves," as they term it, to please any one, even if the hard work does bring increased pay. Why, then, is the Baldwin machinist so willing to work hard?

First of all, the management takes a superlative standpoint. It is the largest locomotive shop, turns out the most and greatest variety of locomotives, gets the greatest effect per man from its hours of labor, and pays its men the highest wages, of any locomotive-building firm in the world. In reality it pays the men a fixed price for each operation, and insists on such a production as will make its workmen earn large weekly wage at shop piece prices. If a man does not earn this large pay, he is followed, without harshness but persistently, until one of two things happens,—either his pay reaches a satisfactory figure, or he gets tired of the constant pressure, feels that he is out of his class, and voluntarily leaves the shops. In no case was any workman, when asked his views of this system, heard to express any desire for a change. The preference was always given unqualifiedly for the piece-price system, which is subject to small, but steady, reductions, as improved tools and methods make reductions possible.

Beside this natural and just preference for piece prices, there is a strong pride manifested among the workmen, which is easily understood: and here is another cause, perhaps the most potent of all, in the personality of the management of the shop in the past and present. Mr. Baldwin himself was a very kind, humane, and just man, as well as a mechanic of unusual ability. He helped and counseled his men. Mr. Parry was another man of equally noble and admirable character, and continued the policy inaugurated by Mr. Baldwin. Every mechanic who shows powers beyond the sphere of his employment is advanced until his limit of usefulness is reached. There is no favoritism; efficiency is the only standard; hence every man feels that he is made of the best possible use by both the management and himself, which is a most happy and valuable frame of mind for any workman in any shop. In consequence of this pushing of men forward, there are a great many very bright youths about the Baldwin shops who have no fixed place, but are put wherever their services are of the most use, and

these have the prospect of advancement immediately before their eyes at all times; there are, on the other hand, many employees of very long standing, 30, 40 and even more years of steady work being very common. Between the young men, eager to do all they can, and the old hands, thoroughly satisfied that they always had full pay and full consideration for all their services, it is easy to see how the management can maintain its policy of driving machine tools to the limit of belt power with the hearty concurrence and coöperation of their workmen.

The mechanical and commercial success of the Baldwin establishment, its continuance and constantly-increasing growth, while generations of its managers pass away, and the contentment of its workmen give the strongest possible testimony to the correctness of its internal policy. It must be held as proved that machine tools should be regarded and treated as containing certain total possibilities, which are most profitably exhausted in the most rapid manner possible; that it is an error to prolong the life of a machine tool by light performance demands; and that the sooner a tool is worn out in effective production the better and more profitable the management under which that machine tool was carried through its useful career from the hands of its maker to the scrap heap.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES, GREAT BRITAIN AND THE BRITISH COLONIES.

INTRODUCTORY.

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States and Great Britain; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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ARCHITECTURE & BUILDING

Steel-Frame Building Construction.

A MEETING and banquet of the New York Architectural League was held on June 5, at which an address on the above subject was delivered by Mr. Geo. B. Post. A synopsis of this interesting address is printed in *The Engineering Record* (June 15). Mr. Post traced the advent of the tall office-building to the introduction of passenger-elevators in the Equitable Life Insurance building, New York, in 1868. Notwithstanding Mr. Post has been professionally connected with some of the most notable tall buildings in the country, he very positively declares them to be "nuisances unless proportioned to the width of the streets they stand upon.' After the passenger-elevator, the metal cage construction of framework was the next impulse imparted to the tall office-building. But defects in this system are pointed out.

Mr. Post expressed great hopes of "being able next year to invite the assistance of the members of the League in securing legislation restricting the heights of buildings," and remarked that "under these circumstances it was an instance of the irony of fate that he should have been called upon professionally to construct some of the highest office-buildings, and perhaps the very highest office-building, ever yet built,—namely, the one now in progress for Mr. H. O. Havemeyer, on the site of the old *Herald* office at the corner of Ann street and Broadway, New York city. The necessity of erecting several of these structures had led Mr. Post to give very careful detailed study to cage construction, its difficulties and dangers, and to attempt to introduce some modifications, which he hoped were steps in the direction of their removal. If calling the attention of the members of the profession to those defects of the cage, and setting their inventive faculties on his work, results, as he hoped, in making steel-cage construction as surely permanent and lasting as brick or stone, the objects of his remarks will be more than accomplished."

As ordinarily constructed, "with no provision for preservation except what is offered by painting and the masonry" where built into the wall from 4 to 12 in. thick, Mr. Post points out three dangers: "first, from the corrosion of the metal; second, from expansion produced by great exterior conflagrations; and third, from inadequate provision for wind strains. Several investigations and consultations with chemists and experts have established the conclusion that paint is effective as a preservative of iron or steel in direct proportion to the amount of linseed oil which it can carry, the most being carried, as a rule, by the lightest pigment; consequently lamp-black, if it would dry, would be as good as any. Graphite comes next, and he intended to use it. If inspection could be perfect, red lead would probably make one of the best of paints, but it has the property of setting very rapidly in oil, and, if it has begun to set before it is applied, is almost worthless. To be at all efficacious, paint must be applied in dry weather to steel which is clean, free from foundry scale, and absolutely dry."

Contrary to Mr. Berg (see review in department of civil engineering, in the present number), Mr. Post disapproves of the use of iron oxid paints, on the ground that the life of such paints corresponds with the life of linseed oil, which he fixes at about 6 years, "and, when the oil has oxidized, the residuum of the paint consists of iron rust that will promote corrosion instead of preventing it.

"Illustrating the way in which, under certain circumstances, steel and iron will sometimes corrode when it ought not to, or be preserved when it could be expected to corrode, Mr. Post showed some samples of iron beams taken from the ceiling over the boiler-room in the old *Times* building, New York, and from a girder in Sedgwick Hall, the former county court-

house of Lenox, Mass., both of which were completely destroyed by corrosion in 40 or 50 years' service. He also exhibited a farmer's hoe dug up out of the mud under the foundations of No. 18 Exchange Place, New York city, where it had probably been buried about 50 years, without any marked injury, the surface being apparently in about the same condition as when buried, and covered with a black film.

"The second danger by which the cage construction may be menaced arises from the possibility of fierce exterior fires in the adjacent building. In a cage structure 200 or 300 ft. high with riveted connections of proper form and ordinary protection, Mr. Post was of the opinion that the temperature distortion from a greater exterior conflagration would be sufficient to expand the lines of support and twist the cage out of shape, so as to produce dangerous strains and distortions, and possibly shear the connection rivets. In either case the building might be left in a dangerous condition. In ordinary structures he considered the danger from wind strains to be much less than has been supposed; otherwise, many buildings that now stand securely must have been destroyed. Nevertheless the architect is rash who ignores wind strains in the design of a high building."

These samples of the address will show its general practical character. No doubt, when this matter is brought before the legislature, the influence of the Architectural League, led by an architect of the ability and standing of Mr. Post, will be able to secure the desired legislation.

Acoustics of Public Buildings.

UNDER the title "Sound in Its Relation to Buildings" Mr. H. W. Burrows read an interesting paper (March 25) before the Royal Institution of British Architects, which, published in the *Journal* of the institution, was reprinted in *The American Architect* (May 18). The paper is long, and comprises a list of world-famous buildings noted for acoustic effects bad and good, and also a reference to the later writings on the subject scattered through books, technical periodicals, and transactions of scientific technical societies. The following is an abstract of some of the more interesting and important parts of the paper.

The inherent difficulties of the subject are great, and they are by no means lessened, but amplified, by the strange divergence of opinion at times expressed upon one and the same point,—one observer pronouncing a building to be good for sound, while another condemns it. This may, in part, be attributed to the different uses to which the building is subject. "To put it simply," says Rev. Compton Reade, speaking of churches, "just as that concert-room which is best for voices is worst for instruments, and *vice versa*, so the church most suited for oratory is least suited for harmonic effects." But, conversely, other writers contend that there is no instance of an apartment where music is heard to advantage where a speaker does not find himself free from restraint, oppression, or a necessity for exhaustive exertion. Therefore, our problem is plainly to build our apartment, whatever it is intended for, as if it were a music-room, and we are safe.

It is only by a patient accumulation of facts that scientific truths can be established, and no cursory dismissal of a subject, on the ground of its having been already well discussed, should be tolerated. The probable existence, for instance, of such a constituent of our atmosphere as argon was not even suspected till quite recently.

As the limits of distance to which an average speaker can be heard are about 90 ft. in the direction to which he speaks, 75 ft. on each side, 30 ft. to the rear, and 45 ft. vertically, authors have endeavored to group buildings into classes,—those, first, which fall within the range of voice, and in which, therefore, sound proceeds from the speaker to the listener by direct radiation; and, secondly, those which exceed the above dimensions, and in which the sound must be conducted, assisted, and reinforced by the design, construction, and materials.

Many buildings without the slightest obstacle between speaker and hearer, and under one roof, are decidedly bad for

sound, giving rise, in some instances, to confusing reflections and consequent echoes, and in others to great decay of sound through the dispersal of the sound rays upward in the large open roofs required to cover single spans of wide dimensions.

"If rectangular rooms are adopted, some authors consider they are improved if one dimension is longer than the other. The late Dr. Brewer considers that the best form for the interior of such rooms is that their length be about two-thirds greater than their breadth, in order that the sounds reflected from the side walls may mingle with the voice and strengthen it. As sound-waves are propagated in spherical layers from their point of origin, it has often been imagined and urged that curved forms are the best to adopt for acoustic reasons, and many opinions have been expressed both for and against this view. The ellipse is one of the worst forms of plan, as is proved by the acoustic failure of the Albert Hall in London. The circular plan has given widely varying results. Octagonal plans are prolific of echoes. Plans with curved ends having sides produced somewhat in the manner of a basilica have been successful."

The London county council chamber is cited as an example.

"The amphitheatrical type of plan has often been adopted for lecture halls and theaters, and it certainly possesses many and distinct advantages, so far as the seating capabilities are concerned, and in many instances has proved successful from an acoustic point of view; but there are notable exceptions, among which may be mentioned, as chiefly defective from an excessive sonorousness, the semi-circular room of the Fine Arts School at Paris, which is described by Radau as being beautifully decorated, but miserable in this respect, as are, also, the great amphitheatres of physics and chemistry in the Jardin des Plantes, and the amphitheatre of physics in the College of France. Efforts have been made in each case to remedy the defects, but with little success. One of the examples often quoted as a successful application of this type of plan is the lecture theater at the Royal Institution, London, plans and sections of which are given in Prof. T. Roger Smith's work. Among buildings planned as elongated rectangles with rounded ends which are successful acoustically may be mentioned the Cincinnati Music Hall, the Concert-Hall at Leipsic, and the Queen's Hall, Langham Place. In the last-named plan the truncated, trumpet-shaped orchestra is a noticeable feature; as in nearly all other examples I have noticed, the curve at the back of the orchestra is concave, parabolic, semi-circular in outline, or a compound curve not easily definable."

"The horseshoe type of plan has been adopted in a large number of theaters, but with varying success, depending in great part upon the materials of which the buildings are constructed, and influenced largely, among other things, by the boxes, which, Scott Russell says, are favorable to the laws of sound, while Zamminer declares them to be monster traps for strangling it."

As to churches and cathedrals, it has been urged by many that the avenue plan is objectionable, and that the columns which carry the arcade cast sound shadows. In this matter we again find most contrary opinions expressed. Scott Russell says: "In a long gallery with wings, the sound cannot be reflected back or rolled along so as to create disturbance, because it goes round and escapes into the transepts; consequently these are favorable to the law of sound." Radau conversely insists that "the transepts of a church are most inconvenient to a speaker, because of the repeated reflections from these recesses, which greatly weaken the sound of his voice." Thus the author justifies his position that neither precedent or authority is a sure guide in acoustic designing, and that neither the failures or the successes of the past guide modern architects in this matter, particularly in designing churches. The effect of details, arrangement of seats, materials, etc., occupy much space in the paper, of which the perusal leaves the impression that the science of acoustics as related to architectural construction is unsatisfactory.

A Plea for Brownstone.

ARCHITECTURE AND BUILDING (June 22) has copied from the New York *Mail and Express* an article by Mr. R. S. Taite, relating to brownstone, which points out reasons for some past architectural failures in the use of this material, and the causes for its flaking, which has been one of the chief objections raised against it as a building material.

It is frankly admitted that "the introduction of competing stones has been a great advantage." The time when New York knew nothing of residential architecture is recalled. "Suddenly there came a change, and, in place of long rows of houses identically alike, there suddenly burst upon the community a craze for variety, which, while it was a relief for the time, soon led to excesses and atrocities in the way of rainbow-colored blocks and nondescript façades of all kinds. It was the same in the country districts, where the rage for Queen Anne architecture soon degenerated into a debauch of Mary Ann house building. The reaction there has come in an appreciation of simplicity and a liking for the old Colonial style, and there has been undoubtedly a similar reaction in town that assures the continued ascendancy of brownstone.

"Not that we shall ever go back to the typical 'brownstone front' of 20 years ago; we have learned a thing or two since then, and one of the most valuable things that the architects have taught us is that we can have beauty in this most staple of stones just as well as in its more gaudy competitors. I remember that a few years ago one of our wealthiest citizens permitted his architect to make the first serious attempt at an architecturally beautiful brownstone residence. The result was pleasing to those who know little of architecture, and was admired by laymen somewhat enthusiastically for a few months until one of our best and most good-natured critics spoke of the building in a magazine article as a 'brownstone cigar-box with architecture appliqué.' The criticism was just, and it was taken in good spirit, and we may possibly date from the day of its utterance the immense strides that have been made in using this material in a truly artistic and workmanlike manner. That this is now done no one need spend more than a half a day on the upper west side to convince himself. Everywhere he will find residences of constantly varying design and of pleasing appearance (both to those who understand the principles of architecture and to those who do not) in which by far the largest part of the visible surface is brownstone."

The artistic sense of the possibilities of brownstone which architects have acquired will, in the opinion of this writer, continue to make brownstone dominant in New York architecture. This opinion, however, is based upon the assumption that the best qualities of this material will be used. The assumption also implies that the stone shall be quarried at the right season of the year. This implication leads to the statement of some facts that will be new to lay readers. "Investigation will show that nearly all the sins that have been charged against brownstone should be laid at the door of careless and grasping contractors. Twenty years ago the facilities for quarrying and storing the stone were nothing like what they are at present, and a contractor who desired to finish a building within a given space of time would frequently rush an order to one of the quarries at a time of year when to fill it meant and could only mean to furnish inferior stone not fit for use in buildings intended to last. The practice of all the Connecticut brownstone quarries at present, I am told, is to shut down completely during the winter months, and enough stone is kept on hand to supply demands during the time. In this way exfoliation, that has caused some people to reject this stone in the past, is prevented. Another important fact is that, when stone is fresh quarried, it contains a certain amount of moisture, which evaporates or crystallizes upon exposure. In other words, stone, like lumber, requires seasoning."

As to the propriety of using brownstone for very tall buildings, by reason of its reducing the amount of light in opposite

buildings and in the street, Mr. Taite says: "This may be true in exceptional localities where many very high buildings frown down upon a narrow street, but I think very little of the argument as to buildings facing wide streets, and nothing whatever of it in the upper part of the city. I am convinced that for three-quarters of the year the glare of a white building would be more objectionable in this climate than such darkness as might be caused by brownstone during the other 3 months. And our snowy, white marble buildings require not more than a year to become dirty, and not more than three to be disreputable, and not more than ten to seem almost coal-black. Of course they are never cleaned, and the consequence is that many of us will soon wish that they had been built of a stone that does not change its color and does not show dirt." The assertion that marble buildings "are never cleaned" is rather too sweeping; in this case "never" might, as in the precedent established in the opera of "Pinafore," be appropriately softened to "hardly ever."

Artistic Domestic Architecture in America.

THE *New England Magazine* for June has a paper by Mr. Barr Ferree on the subject named. The author dates "the development of Artistic American Architecture" from the close of the Philadelphia Centennial Exposition; but he does not consider the impulse given to American art by that splendid collection as the sole cause of the revival of art in architecture. "The educated architect, trained especially for his profession and in a professional manner, is scarcely older in this country than that time. Not that all our present architects are the young men this statement would seem to imply; but the road to the practice of architecture is now almost wholly through the schools for preliminary study, or through the practical work of a trained architect's office; the result is much the same, whether the preliminary schooling is had or not. The road through the carpenter's shop and the work-bench, which in the past produced some faithful men, but few artists, has been closed for all time. The present revival has accomplished that, if it has failed in other things.

"The training of architects and the spread of artistic culture have gone hand in hand. Guided by the one, inspired by the other, people to whom the very word architecture was long unfamiliar now profess a more or less general acquaintance with the art, and, when they build, insist on structures of a certain standard of artistic excellence, depending for the most part on the ability of the architect whom they employ, and on the taste, if not on the accuracy, of their own judgment. There is still a vast deal to be done. People of the broadest culture, of refined temperaments, are still paying for the erection of the most inartistic structures, and architects without the smallest artistic quality are still commanding lucrative practices. In a genuinely artistic age such things would be impossible. It is a significant indication of our own position in history that we can tolerate them, and calmly rank them among the peculiarities, if not the glories, of our civilization."

The complicated character of American architecture, arising from diversity of requirements, has resulted in confused and indiscriminate growth, and there is no style that is distinctly American. "Of the artistic architect we have but a few, perhaps no more than can be counted on the fingers, perhaps no more than can be counted on those of one hand. But we are no worse off than other nations in this respect, for architecture is so largely a matter of business and of management, and success in it is so often dependent on everything but artistic skill, that the truly artistic architect can only be a rarity even under the most favorable circumstances. And then there is the extraordinary fact that the best of architects, the men whose names are most familiar to the world, whose work is most in evidence and who have the most work to do and the most important, are constantly doing the things they ought not to do, and that in the most extraordinary fashion. But we have architecture in America that is not wholly the product of the artist-architect, work very good in itself, admirably suited for the

purposes for which it is intended, and dowered with a grace of beauty that lifts it above the ordinary, though its creators may not all of them be properly called artists in the truest sense. It is this ability of so many of our architects to produce interesting buildings which renders the outlook so hopeful and which makes American architecture in its best forms—and this, it should be remembered, is the latest—among the most interesting now to be found anywhere." The country house "takes first place in the development of artistic composition in American architecture" by reason of its "importance in number and in example." The suburban dwelling and semi-detached house of modern cities ranks next. But the most pronounced success has been attained in the country house. "Its progress has been real and marked, and its future development must be watched with the greatest interest. There is a freedom from restraint in designing a country house that admirably falls in with the beauty of its situation. Artistically, it is the greatest distinction American architects have achieved that they have so admirably solved this one problem. There is still much to be done before the same quality will have penetrated to other fields of labor. In many other groups of buildings much progress has been made, and an architect who has in the dwelling given evidence of artistic ability is quite likely never to fall back into an inartistic mood when undertaking other problems. The artistic dwelling points the way for similar improvement in other fields."

Waterproofing Brick and Sandstone.

AT a recent meeting of the Australian Association for the Advancement of Science, says *The British Architect*, an account was given of experiments made with the view of ascertaining the length of time that brick and sandstone are rendered waterproof or protected by oil. The oils used were the three commonest and most readily obtainable for such purposes, viz., linseed oil, boiled linseed, and the crude mineral oil known as "blue oil," used for preserving timber. The weatherings were made upon a flat portion of the laboratory roof fairly exposed to the sun and weather. Good, sound, machine-made bricks were experimented on. The amount of oil and water taken up by the sandstone was very much less than that absorbed by the brick, although the area of the sandstone cubes was much greater than that exposed by the bricks. Equal amounts of raw and boiled oils were absorbed; the blue oil, however, was taken up in much greater quantity by both brick and sandstone, but by the end of 12 months the whole of the 13½ oz. of blue oil had apparently evaporated away and the brick had returned to its original weight. The bricks treated with raw and boiled oils remain unchanged. After the second oiling in November, 1890, and exposure for nearly four years and two months, they had practically retained all their oil, inasmuch as they had not lost weight, and were also nearly impervious to water.

The singular feature of this is the alleged continued imperviousness of the bricks notwithstanding the apparent disappearance of the blue oil, as indicated by the weight. A curious physical problem is here presented, provided the testing by weight was correctly performed. In the absence of a cause there can be no effect.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

32409. The Congressional Library Building at Washington. Ill. George Grantham Bain Am Arch–June 8.) 4500 w.

*32414. Durham Cathedral. Dr. Greenwell in the Durham Advertiser (*Arch*–May 31.) 6000 w.

*32415. Bricks. Anon. (*Ill Car & Build*–May 31.) 2500 w.

*32420. Some Characteristics of Saxon Buildings. Baldwin Brown (*Brit Arch*–May 31.) 2500 w.

32504. Hollow Clay Construction. Ill. (Brick–June.) 1300 w.

32558. Steel Frame Building Construction. Ill. Synopsis of remarks of George B. Post (Eng Rec–June 15.) 1400 w.

*32609. Delphi. Ill. (*Builder*–June 8.) 5200 w.

We supply copies of these articles. See Introductory.

*32610. Iron Work. The Grand Period. Ill. J. Starkie Gardner (*Builder*-June 8.) 2500 w.

†32687. Stray Notes on Building and Construction in Ancient India (*Ind Engng*-May 18.) 2700 w.

32700. The Massachusetts State House. Ill. Albert Winslow Cobb (Arch & Build-June 22.) 4800 w.

32702. A Plea for Brownstone. R. S. Taite, in N. Y. Mail and Express (Arch & Build-June 22.) 1300 w.

*32747. The Early Development of the Christian Church. William J. Anderson (*Builder*-June 15.) 5000 w.

*32753. Artistic Domestic Architecture in America. Barr Ferree in New England Mag. (*Arch*-June 14.) 4000 w.

†32762. Annual Exhibition of the Chicago Architectural Club. Ill. P. B. Wight (In Arch-June.) 2800 w.

32764. Concretes, Cements and Mortars. Fred. T. Hodgson (Mfr & Builder-Jan.) 2200 w.

32766. A Norwegian House in England. A. T. Sibbald (Am Arch-June 22.) 1600 w.

32843—$1.50. Address to Students by Francis C. Penrose (*Jour Roy Inst of Brit Arch*-June.) 5000 w.

32844—$1.50. The Legal Position of Architecture in Relation to Certificates and Awards. James Andrew Strahan, with Discussion (*Jour Roy Inst of Brit Arch*-June.) 13000 w.

32845.—$1.50. The Value of Simplicity in Architecture. Ill. I. Halsey R. Ricardo. II. Basil Champneys. III. Francis C. Penrose. With Discussion (*Jour Roy Inst of Brit Arch*-June.) 11800 w.

32846.—$1.50. Style Individuality, and National Tradition. Extract from Address of A. N. Patterson (*Jour Roy Inst of Brit Arch*-June.) 2700 w.

32847.—$1.50. Fever Hospitals. Ill. T. W. Aldwinckle (*Jour Roy Inst of Brit Arch*-June.) 25500 w.

32848.—$1.50. Architecture and the Arts of the Netherlands: Monsieur Van Tsendyck's Great Work. J. Tavenor Perry and J. Starkie Gardner (*Jour Roy Inst of Brit Arch*-June.) 4500 w.

32849 —$1.50. Notes upon the Architecture of China. F. M. Gratton, with Discussion (*Jour Roy Inst of Brit Arch*-June.) 15200 w.

32850.—$1.50. Some Observations on the Notes of Foreign Travel Left by Mr. Wolfe, Sir Charles Barry, and Others. Arthur Edmund Street (*Jour Roy Inst of Brit Arch*-June.) 2200 w.

*32911. The Condition of the Parthenon. Ill. Somers Clarke (*Builder*-June 22.) 1600 w.

*32912. The Durability of a Stained Glass Window. G. E. W. (*Builder*-June 22.) 1600 w.

*32920. Planning Small Houses. T. W. F. Newton. (*Ill Car & Build*-June 21.) 1000 w.

*32921. The Decoration of St. Paul's. W. B. Richmond, with Discussion (*Jour Soc of Arts*-June 21.) 9000 w.

32930. A Brief History of the Beacon Hill State House. Thomas A. Fox (Am Arch-June 29.) 5500 w.

32932. The West Front of Peterborough Cathedral. From Building News (Am Arch-June 29.) 1100 w.

*32948. Surface and Color Treatment of Terra-Cotta. William D. Gates (Br Build-June.) 3000 w.

*33028. The Charterhouse. Anon. (*Ill Car & Build*-June 28.) 2200 w.

*33060. Coventry Municipal Buildings Competition (*Builder*-June 29.) 2800 w.

*33061. Architectural Modelling. E. S. Prior (*Builder*-June 29.) 2200 w.

Serials.

18857. Electrical Science for Architects. Ill. Russell Robb (Am Arch-Began Jan. 13, 1894—11 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build-Began Jan., 1894—18 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (*Plumb & Dec*-Began March, 1894—15 parts to date—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (Arch & Bldg-Began Oct. 13, 1894—8 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (*Ill Car & Build*-Began Nov. 9, 1894—12 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Build-Began Nov. 24, 1894—8 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (*Builder*-Began Jan. 5—23 parts to date—30 cts. each.)

28805. Fire-Proof Floor Arches. Ill. George Hill (Br Build-Began Jan.—4 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone-Began Feb.—Ended June—5 parts—30 cts. each).

31880. Practical Masonry and Stone-Cutting. Ill. Fred T. Hodgson (Stone-Began May—2 parts to date—30 cts. each).

31911. The So-Called Colonial Architecture of the United States. Ill. O. Z. Cervin (Am Arch-Began May 18—7 parts to date—15 cts. each).

32206. The Blackpool Tower. Ill. (*Engng*-Began May 24—Ended June 21—3 parts—30 cts. each).

32660. Practical Carving. Ill. Dominick A. Walsh (Stone-Began June—1 part to date—30 cts).

32701. The Study of Buildings To-day and in the Past. F. C. Penrose (Arch & Bldg-Began June 22—Ended June 29—2 parts—15 cts. each).

32947. Architectural Terra Cotta. Ill. Thomas Cusack (Br Build-Began June—1 part to date—30 cts).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

President Morison's Address.

THE annual address of President Morison before the American Society of Civil Engineers at its twenty-seventh annual convention at Hull, Mass., June 18, departed from the usual custom of such addresses, and dealt with what the speaker styled "The New Epoch,"—the epoch of the manufacture of power. *The Engineering Record*, which prints a very full report of the proceedings, publishes also the full text of this address. The "new epoch" is treated as still in its incipiency. It is predicted that it "will finally make the human race a single great whole, working intelligently in ways and for ends which we cannot understand."

"It is not too much to predict that, when the full effects of the manufacture of power are realized and the world has passed through the development which the next 10 centuries will see, the time when man began to manufacture power will be recognized as the division between the ancient and the modern, between ignorance and intelligence, between the national strife, which may then be classed as barbarism, and the new civilization, whatever that may then be called."

This epoch means more to the profession of civil engineering than to any other. "The manufacture of power is the work of the engineer; the inventions which have led to it were made by engineers,—in fact, it has made possible the profession of the civil engineer. The civil engineer is, briefly, a man who, with the knowledge of the forces and materials around him, uses that knowledge in the design and construction of engineering works. His business is to design the tools by which the sources of power in nature are directed for the use of man. A body of civil engineers should include the choicest minds in every branch in the engineering profession. . . . . We welcome into our society all branches of engineering, but not all engineers. We welcome every engineer who applies a knowledge of the powers of nature to the design and construction of engineering works; we welcome the architect who uses this knowledge in his designs and construction; but the architect who treats his profession as a fine art to decorate a construction which he cannot design belongs elsewhere. Intelligent knowledge of the great powers in nature is the fundamental requirement for a civil engineer. On this substructure a superstructure of actual design and construction must be built to make the complete professional man."

Qualifications of civil engineers to meet coming requirements are indicated. "The physical laws of power and strength are mathematically exact, and admit of no trifling. As the epoch progresses, the requirements for each individual will become more complicated. The theologian and the metaphysician may claim that an education based on the laws of nature leaves out the highest part of existence; the biologist and the physician may claim that matter endowed with life is a higher organism than the inanimate matter with which the engineer has to deal. But, however true these claims, their laws have not the mathematical rigidity, the clear definition, and the thorough discipline which mark the laws with which our profession works. The engineer cannot shield himself under doctrines or theories which he accepts, but cannot understand. Dealing with accurate, definite laws, and guided by the corrective touch of physical nature, the education of the engineer will become more necessary, more thorough, and more exact than that of any other professional man. This is the training which the civil engineer of the new epoch must have. This knowledge he must have, or he must be classed as a workman.

"The civil engineer in the new epoch must sink the individual in the profession. The engineering work of the future must be better work than has ever yet been done. The best work is never done by

separate men; it is only accomplished when professional knowledge so permeates all members of a profession that the work of one is virtually the work of all. The first steps are made by individuals, but the best results come later. The name of Watt will ever be identified with the successful introduction of the steam engine, and nothing should be allowed to belittle his reputation; but there are ten thousand men to-day any one of whom can build a far better engine than James Watt ever could; they can do it, because they are imbued with all the work the engine-builder has done for more than a century; they do it as members of a profession, who are all working together. In the Middle Ages Gothic cathedrals were built throughout Northern Europe; they are exquisite works; no modern architect can approach their beauty; the reason is that the men who built the Gothic cathedrals worked together as members of a guild which was thoroughly imbued with the spirit of building these churches. In no period of the world's history has marine construction had any significance compared with what it has to-day, and it is because the great shipbuilders are working together, each having the practical benefit of what they are all doing; they are working together as members of a profession rather than individuals, and their work is becoming more uniform and more perfect.

"The civil engineer of the new epoch must be a specialist. No man can learn to design all the tools by which the powers in nature are to be directed. The work is too great for one man to master. The best results will only be obtained by concentrating effort in a single line. But though the civil engineer must be a specialist, his specialty must not be of a narrow kind; he must have that general knowledge and training which make the liberally educated man; the real difference between a liberal education and a special education is that one teaches the student to use his mind, and the other gives him information. The civil engineer must have had the mental discipline which qualifies the mind to investigate kindred subjects beyond the limits of his own specialty; his education must be broad enough for this, or he will not be a civil engineer. The knowledge of his specialty will be only part of his education; the mental discipline will be more.

"And last, the civil engineer of the new epoch must fill many positions which are now held by men of different training. The knowledge of the tools, both large and small, which men are using must be the strongest qualifications for their use. Accurate engineering knowledge must succeed commercial guesses. Corporations, both public and private, must be handled as if they were machines, and the men who will so handle them will find their best training in the education which will make the best civil engineers."

The duties and responsibilities of the American Society of Civil Engineers, its objects, and its relations to other engineering societies are then alluded to, and a general discussion of engineering tools completes an unusually interesting discourse. A general classification of engineering tools is made into those "which manufacture power," those "which transmute power," those "which transmit power," and those which make up "the rank and file of miscellaneous tools."

Iron Bridge Painting.

In our June number we noticed a report on preservation of iron structures prepared by Mr. M. E. Gerber. In line with that able report is a report by Mr. Walter A. Berry (made in the course of his professional duties) on the "best paints and methods for painting iron bridges, viewed from the standpoint of a railway engineer," extracts from which are printed in *Engineering News* (June 6).

The fact that an article or method is widely used, though not absolutely conclusive, is regarded as at least presumptive evidence that it is useful and adapted to its purpose. The information upon which the report is based has been obtained from about thirty different railways. It is difficult to overestimate the value of a mass of information so obtained and directed to a single practical subject. Un-

fortunately the communications thus received are privileged, and in the extracts Mr. Berg gives only "his own personal deductions and conclusions."

He classifies the paints in common use as follows: "(1) Metallic or iron paint, consisting of oxid of iron and linseed oil. (2) Red lead paint, consisting of red oxid of lead and linseed oil. (3) Asphalt paints, consisting of mineral and artificial asphalts or coal tar, alone or combined with each other, and frequently mixed with metallic bases, oils, and other materials. (4) Carbon and graphite paints. (5) Patent paints."

Mixtures of white lead are unfit for priming except where light finishing coats are to be used. "The use of light colored paints, the superiority of which, as claimed by the manufacturers, consists in the preponderance of dark-colored bases, such as asphalts, carbons, red oxids, etc., is not warranted, as the lighter the shade desired, the larger the quantity of foreign light-colored pigment that has to be used to counteract the dark color of the base, thus diminishing the amount and destroying the advantages, if any, of the much advertised base." Ochre paints have not had an extensive trial, but have been recommended by Dr. Charles Dudley, the chemist of the Pennsylvania railroad, The differences in the conditions and requirements for painting iron work of bridges compared with either wood or underground pipes or ships' bottoms are alluded to. In the first case atmospheric influences are unimpeded.

Metallic or iron paints consist, or ought to consist, of oxid of iron ground in linseed oil. In such paints, however, as are obtainable in commerce, "adulterations and improper applications have been so common as to have caused" much to be said and written against iron paints. In a prime condition, and properly applied, iron paint has the merit of cheapness, and it has been used for a long time, giving many proofs of its usefulness for a variety of purposes. Not only the iron oxid, but also the linseed oil, must be pure to secure good results. Such paints, "followed up in due time with additional coats of the same material, will give very good practical results for iron bridges, in spite of theoretical arguments against the use of iron paints in general for priming iron." The practical difficulty remains of getting good paint, at the cheap prices sought by purchasers; and there is a "tendency of the purchasing and administrative departments of a railway to judge the quality of materials and workmanship by the question of cost."

Red lead paint is the red oxid of lead mixed with linseed oil. It is improved for bridgework by addition of lamp-black, which causes it to set less quickly, and changes the tint from a glaring red to a chocolate color. It is one of the best inert paints. It should not be too long mixed before application; else its tendency to set quickly will render it hard to apply. "Its use is becoming very general for railroad-bridge painting, especially for priming coats, and after toning down with lamp-black or graphite, and also for finishing coats, wherever light-colored finishing coats are not called for. It is nearly as cheap as oxid-of-iron paints, if its greater covering capacity, as claimed by the manufacturers and a great many users, is considered; while, on the other hand, it becomes as costly as any high-colored paint on the market, if a low average covering capacity is assumed. On this point the statements are most conflicting. The manufacturers claim a covering capacity of from 750 to 1200 sq. ft. The results of painting about 3000 lin. ft. of bridging on the St. Louis & San Francisco Railway would seem to be about 400 sq. ft. for the first coat, and about 1000 to 1100 sq. ft. for the second coat. The fact of the adoption of red lead on such a large number of railways, however, certainly seems to indicate that its covering capacity and price, with the practical results attained, must be favorable, as compared with the cheaper iron oxid and asphaltum paints which it replaces.

"As to adulteration, it can be said that the quality of the pigment, which has to be purchased in powder form, can be readily tested by simple tests, and that in the paint trade it is considered that red

lead bought of the large manufacturers, not of middlemen, can be relied on for purity. In other words, there is less chance for adulterations to exist than in purchasing ready-mixed patent or iron paints." Manufacturers of other paints on the market, however, deny the superiority of red lead paint, and attribute its extended use on railways to a stimulation of purchases by energetic advertising and active and able salesmen employed by the "Lead Trust." The author thinks, however, these statements not warranted by facts. An admitted objection to red lead paint is its tendency to run on slanting or vertical surfaces; but this tendency can be largely eliminated by adding lamp-black or graphite, or a little japan.

The term "asphalt paint" covers so many mixtures sold under that name, in which mineral and artificial asphalts and coal tar, alone or combined with each other, are found, that it is difficult to define what "asphalt paint" is, as sold mixed, ready for use. "A properly-constituted pure asphalt paint (not a coal tar, benzine, and mineral or fish oil mixture) would seem to be worthy of extensive trial, especially for priming iron. Cheap so called asphalt or asphaltum paints are not included in this recommendation, as the price of the article excludes pureness. This fact, combined with the uncertainty as to what the cheap mixture really contains, makes it preferable (if a cheap paint has to be used) for the purchaser to buy, at the same cost, or generally even at less cost, iron oxid powder and pure linseed oil, and have the mixture made under his own supervision."

Notwithstanding this, an asphalt paint made by a New York house, and consisting of asphaltum, linseed oil, turpentine, and Kauri gum, is highly spoken of as a new departure in bridge painting,—namely, the introduction of a varnish-like finish and consistency offering a much more impervious coating than the ordinary oil paint. Graphite and carbon paints have given satisfaction, but it is advised that they be obtained from firms of the very best standing.

Besides this general discussion of the qualities of paints, there is a discussion, occupying about six columns, of essential elements and conditions for securing good results with paints in general. This covers very thoroughly the entire field of selection of materials and application of paints, preparation of surfaces, adaptability to special uses, the supervision of men employed to do the work, etc., and closes with the following recommendation:

"It is very desirable to obtain promptly some full-size comparative tests,—*i. e.*, paints which seem to offer sufficient good features to warrant these tests being made, so as to establish whether these paints will give better results than red lead or iron oxid paints, especially for priming iron:

"Dr. Dudley's Paint Formula: 39 lbs. French ochre, 1 lb. lampblack, 54 lbs. raw linseed oil, and 6 lbs. japan.

"Black Bridge paint, of Edward Smith & Co., 45 Broadway, New York city.

"Bessemer paint, of Messrs. Rinald Bros., Philadelphia, Pa.

"Graphite silica paint of Joseph Dixon Crucible Co., Jersey City, N. J.

"Carbon primer of Sherwin-Williams Co., Cleveland, O., and 178 Fulton street, New York city.

"Graphite paint of Detroit Graphite Manufacturing Co., Detroit, Mich."

Submarine Blasting at the Iron Gates of the Danube.

A DESCRIPTION of the operations whereby the removal of the rocks which obstruct passage of vessels of draft exceeding 6 ft. between Bazias and Sibb in the river Danube—rocks which have long been collectively known as the "Iron Gates"—is given in *Transport* (June 14). This obstruction to navigation, which attracted attention even in ancient times, was tolerated, after some public attempts at removal and many abortive proposals for the much-needed improvements, until Sept. 18, 1890, when the work of removing 360,200 cu. meters of rock commenced. Nearly two-thirds of this rock will be removed from shallow water along shore; the rest has to be taken from the river channel, and 270,000 cu. meters will be required for dams and dikes. The channel at the "Iron Gates" will be cut open to a

width of 89 yds. for a distance of 3000 yds., and to a depth of 6 ft. 6 in. below low-water mark. Dikes will be built that will further increase the depth.

The most notable feature of the work is the method of submarine blasting employed by the engineers in charge, some of which is accomplished by a system of mining very similar to that employed by General Newton in removing the Hell Gate rocks in the channel of the East river at New York.

"Col. Lauer's method of subaqueous blasting, which was at first regarded as the only one available, was found unsuitable for some portions of the work, although it gave most satisfactory results in the preparation of the bridge foundation at Peterwarden, on the Danube. The system is carried out by mooring in the usual manner a barge with wrought-iron framework over the front and with a number of apertures through which rods made of gas-tubing can be slipped down to the river-bed from a fixed point overhead. On the end of the rod a charge of 2.2 lbs. of dynamite in a tin case, fixed to a short wooden rod, is attached to a suitable holder. The charges are fired by electricity and, as a general rule, only the wooden lengthening piece is broken. The rocky bed of the river is removed in steps with the free side down stream, so that all the small *débris* is swept away by the current. Difficulty was experienced in working by this system at the 'Iron Gates,' for, when a piece of rock 6 ft. deep had to be removed, it had to be taken off in three or four layers, and, when the attempt was made to start the second layer, the shots had very little effect when the rock was soft, and it seemed as if the rock had been compressed by the first set of explosives. There was, in addition, the danger of leaving needle-like points projecting, which would have been most dangerous to passing vessels. There was a further difficulty, but of a less serious character, caused by the wooden lengthening pieces becoming so tightly jammed into the iron rods that nothing short of burning them out was sufficient to remove them."

For heavier work, as at Greben point, the system of chamber mining was adopted. "The spur of the mountain had an almost vertical face towards the river, and operations were commenced on it at different levels simultaneously; and a tunnel was driven to carry away the spoil. The first material removed was pumped into the river, and sufficient ground was made to build locomotive sheds and workshops, and to form a connection with the cluster of workmen's houses. When the rock was cut back sufficiently far from the shore, chamber-mining was resorted to. The chambers were very simple in shape. A heading 3 ft. wide by 4 ft. high was driven about 80 ft. quite straight, and then a chamber 6 ft. 6 in. cube was blasted out at right angles to it. This was charged in the usual way, and the heading was closed, first with brickwork set in cement, and then with dry stone-work. One of the chamber-mines fired last year had a breast of 20 yds. and a height of 33 yds. A charge of about 4 tons of carboazotine was used, with the result that about 700,000 cu. ft. of rock were thrown down. The largest blast was fired in May, 1894, when 2,100,000 cu. ft. of rock were dislodged by a charge of 12 tons of second-grade dynamite."

The most difficult part of the work was, however, at the Inez Rapids. Here there are two systems at work, the more important of which is that of the Ingersoll- Sergeant Rock-Drill Company. The Fontane system is employed at Izlas and Tachtalia. "The Ingersoll 'scow,' as the makers term it, is provided with spears, one at each corner, up which the scow can be raised by hydraulic jacks fed by a Worthington pump. By this means the scow can be lifted out of the water so as to rest on the four spears, thus giving a working platform independent of the movement of the water. As the current is strong in this part of the river, and carries a good deal of detritus, a protecting tube, held by a special iron framework, and pressed against the river bed, surrounds the drilling bars. When the drilling of a hole is finished, it is washed out by a jet of water, and the charge of dynamite is lowered into the bore-hole through the projecting tube, which is split along one side to allow the wires of the

electric fuse to pass. When all the bore-holes for one blast have been charged, the scow is lowered into the water and floated away to a distance of about 50 ft., the charges being fired simultaneously by electricity."

It is stated that the Ingersoll scows at Inez, though there has been some complaint of their want of steadiness, have, on the whole, given good satisfaction. In the Fontane system two barges are emptied by a platform on which the drills are mounted, and, while it gives a greater range of work, its want of steadiness, due to weakness of construction, is a subject of complaint.

The Baltic Canal.

THE imposing celebration of the completion of the Baltic canal has elicited so many comments upon this new and great waterway that we hardly know which to select for special review. *The Engineer* (June 14) states that it is the "realization of a plan long cherished by both Germany and Denmark." The German ocean and the Baltic are now connected by a canal "answering all requirements from a naval as well as a commercial point of view. The idea of such a canal is by no means new; similar schemes have been in existence for centuries. Christian III. of Denmark, in 1539, recognized the importance of such a waterway; Wallenstein, in 1626, had actually got workmen together to commence operations when his deposition put a stop to them. Oliver Cromwell conceived the idea of buying the town of Wismar from Sweden as a preliminary step toward a similar scheme. In all, some sixteen plans, more or less practicable, have in the course of time been brought forward and received serious consideration. The present canal is the work of Mr. Dahlstrom, a Hamburg shipowner, who, in 1878, attempted to raise the necessary capital by forming a company. In this he failed; but he handed over to the government full particulars of all his plans, preliminary surveyings, and experiments which had been carried out under the superintendence of Mr. Boden."

"The new canal leads from Brunsbuttel, on the right shore of the lower Elbe, forming a slight curve through Holstein in a north-east direction to Rendsburg, whence it continues in an easterly direction, reaching the Fjord of Kiel at Holtenau, within the immediate vicinity of the great naval station. The port and bay of Kiel form one of the largest and most perfect anchorages in the world, and the selection of Kiel as naval port of the North German Union in 1867, and now of the German Empire, was the only possible one."

There are no locks except at the two ends of this canal. These great locks are chiefly for the purpose of protecting the canal from strong tides and currents. That on the Baltic terminus will need to be used only when storms raise the tides to an unusual height. At the other end the rise and fall of the tides is so notable that, except for an interval of about 3 hours between tides, the lock-gates must be closed. The completed work has cost $36,300,000, and the construction has occupied only 8 years.

Engineering News (June 20) gives the dimensions of the prism, etc. "The normal section of the canal has a bottom width of 65.6 ft., a surface width of 183.7 ft., and a depth of 30.5 ft. These dimensions are based upon rules providing for the passage of a warship of 72.16 ft. beam and a draft of 24.4 ft.; and the width at keel-level is to be sufficiently great to pass with due care two ships of ordinary commerce of 38.4 ft. beam and 21.3 ft. draft. Of curves of less than 2500 m. radius the width of the canal is increased, according to the formula, $26-\frac{\text{radius}}{100}$; the enlargement for 1000 m. radius being 52.48 ft. The resistance to motion in this canal is but little more than in an open river. In sections where stone is abundant the sides of the canal are paved with 12 in. of granite laid on 8 in. of gravel. In other sections slabs of beton are used for paving, 8 in. thick and 8.85 ft. long by 4.92 ft. wide. The locks are each 720 ft. long, with a useful length of 492 ft. and a free width of 82 ft. In design they differ little from locks usually used for similar purposes. The gates are handled by hydraulic power, and

as the pressure on these large gates is very considerable, each gate has in it a supplementary relief gate, which is only shut down after the main gate is closed. This feature is claimed as a novelty in lock construction by the chief engineer."

The Harlem River Ship-Canal.

THE *Iron Age* (June 20) publishes a good account of this piece of engineering, with a map. The work has presented no special difficulties, and is chiefly of local interest. It affords a waterway between Manhattan island, the site of New York, and the main land for vessels of 8 ft. draft, or less, through the widened and deepened channel of the estuary known as Spuyten Duyvil creek, a distance of 1¾ miles. The waterway will permit the passage of nearly all vessels plying the Hudson river, scarcely any of which have a draft exceeding that named. The *Iron Age* article is chiefly historical. The canal was formally opened June 17.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

*32402. Improving the Delaware at Philadelphia.—A Notable Engineering Work. Ill. John Birkinbine (Eng Mag-Aug.) 4000 w.

†32616. Expansion Bearings for Bridge Superstructures. Ill. George S. Morison (Am Soc Mech Eng-June.) 400 w.

32971. The Casseuil Drawbridge. Ill. From La Nature (Sci Am-July 6.) 600 w.

Canals, Rivers and Harbors.

*32426. The Principles of Harbor Construction. Anon. (*Trans*-May 31.) 1800 w.

32475. The Chicago Drainage Canal. Ill. (Sci Am-June 15.) 1100 w.

32510. The Harlem River Improvement and Ship Canal. Ill. (Sci Am Sup-June 15.) 1600 w.

32532. The Hussey Delivering Dredge. Ill. (Eng News-June 13.) 2000 w.

32533. The Handling of Dredged Material. Editorial (Eng News-June 13.) 5000 w.

*32572. The Jonage Canal. Ill. (*Eng*-June 7.) 1900 w.

*32607. The Baltic and North Sea Canal (*Trans*-June 7.) 2000 w.

32662. The Harlem River Ship Canal, New York. Ill. (Ir Age-June 20.) 1800 w.

32685. The Completed Canadian Soo Canal (Sea-June 20.) 700 w.

32691. The North Sea and Baltic Ship Canal. Ill. (Eng News-June 20.) 1100 w.

32692. The Canadian Canal at the Sault Ste. Marie (Eng News-June 20.) 500 w.

32693. The Harlem River Ship Canal (Eng News-June 20.) 3800 w.

*32710. The Baltic Canal. Ill. (*Eng*-June 14.) 2000 w.

*32730. The Iron Gates of the River Danube (*Trans*-June 14.) 2000 w.

32806. The Chicago Drainage Channel. Ill. (Sci Am Sup-June 29.) 2200 w.

*32910. The North Sea and Baltic Canal. Ill. (*Builder*-June 22.) 2500 w.

*32990. Dredge Construction in the Clyde (*Trans*-June 28.) 1800 w.

Hydraulics.

†32635. Analysis of the Tremont Turbine. Ill. DeVolson Wood (Am Soc Mech Eng-June.) 1500 w.

32937. Notes on Hydraulic Elevators. Ill. (Mach-July.) 500 w.

Miscellany.

32476. Limes and Cements. Extract from paper by Charles D. Jameson (Sci Am-June 15.) 3300 w.

†32625. Rustless Coatings for Iron and Steel. Third Paper. M. P. Wood (Am Soc Mech Eng-June.) 16000 w.

32816. The New Epoch and the Civil Engineer. George S. Morison (R R Gaz-June 28.) 6500 w.

*32826. Notes on the Construction of the East River Gas Tunnel. Walton I. Aims (Jour As Eng Soc-May.) 6000 w.

32855. President George S. Morison's Annual Address (Eng Rec-June 29.) 8000 w.

†32986. Cements. K. Horgan E. (*Ind Engng* June 1.) 700 w.

Serials.

28498. Thames Bridges. Ill. (*Engng*-Began Jan. 4—16 parts to date—30 cts. each).

31702. Cement Testing. Cecil B. Smith (Can Eng-Began May—Ended June—2 parts—15 cts. each).

31829. The Chicago Main Drainage Channel. Ill. (Eng News-Began May 16—6 parts to date—15 cts. each).

31871. Glasgow Harbor Tunnel. Ill. (*Engng*-Began May 10—Ended June 28—4 parts—30 cts. each).

32334. The North-East Sea Canal. Ill. (*Engng*-Began May 31—5 parts to date—30 cts. each).

32686. The Rushikulya Project. Ill. (*Ind Engng*-Began May 18—1 part to date—45 cts).

32736. The Titicus Dam. Ill. (Eng Rec-Began June 22—1 part to date—15 cts).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Ventilation of Hospitals.

IN our July number we mentioned in this department an experiment in ventilation carried to an unsuccessful termination at the Cambridge Hospital,—namely, an attempt to cool the air used for ventilation by passing it over the coils used in winter for hot-water heating, these coils being kept at, or nearly at, the temperature of the water in the city mains which was pumped through them. The temperature of the water so circulated was too high, and the area of the surface of the coils was too small for effective cooling. The subject of improved ventilation for hospitals appears, however, to be again coming into prominence. This is particularly the case with reference to new hospitals projected or in process of construction. The *Lancet* (London) has recently described and discussed an instalment for ventilating the new General Hospital at Birmingham, England, in an article of which a considerable portion has been reprinted in *The American Architect*.

This instalment is intended to purify both the inflowing and outflowing air,—the first with reference to interior, and the second with reference to exterior, sanitation. The system, applicable to all hospitals, is, therefore, of greater importance as regards hospitals for infectious diseases.

The architect of the building, Mr. Wm. Henman, recognizing the efficiency of air filtering as successfully applied in the "Key" method of ventilating hospitals, infirmaries, and schools, conceived the idea of also filtering the outflowing air, and of disinfecting it, to prevent any active germs of disease from escaping to the exterior.

The hospital is now in process of erection, and is expected to reach completion in about 2 years. The determination of the success or failure of Mr. Henman's scheme will, therefore, have to await the completion and occupation of the building. It is, however, based on correct principles, and we are satisfied that, if skilfully carried out, it will be demonstrated to be an important and useful innovation. Moreover, the experiment will be on a scale to develop all practical difficulties that possibly may arise. If these can be surmounted, its general feasibility for hospitals, large and small, will be established. Twenty million cu. ft. of air per hour will be required. It is no small undertaking to filter and purify effectively this large volume. The screen for this purpose will have a surface of 2000 sq. ft.

"In applying the Key scheme to a hospital, a selection is first made of a position uncontaminated by surroundings (or of more than one such position, if the buildings are extensive), where air can be drawn in towards an extended screen, kept moistened with water and periodically flushed to free it from the large amount of dirt which it intercepts. The screen is formed of a series of cocoanut-fibre cords stretched vertically, and interlaced with copper wire to keep them in position. On the other side a coil of steam or hot-water pipes is placed to prevent freezing in the winter, and on the inside are other heating coils arranged so that by means of doors or louvres the air passing through or under them may be regulated. It is then forced onward by means of a rotary fan or air-propeller, set in motion by steam, water, gas, or other power,—preferably an electric motor,—and finds its way to the several rooms, wards, or corridors by means of a wide and lofty horizontal duct and up-flues, all calculated to the required areas, at the base of which are more heating coils, together with a simple contrivance by which both the volume and temperature of the air-supply to any separate part of the buildings can be adjusted to a nicety. The air enters where required by means of trumpet-mouthed openings, at about two-thirds the height of the story, so as to disperse evenly throughout the apartment; and at the

same time it expels an equal amount of air, principally through openings provided on the same side of the room as the inlets, up-flues of the proper sectional area, into ducts in the roof, and thence to the open, through valved and louvred turrets or flaps, four-sided, so that outer movement of the atmosphere shall exert no adverse influence upon the outflow. These outlet air-valves are so constructed as to place the air within the building under a slight pressure of about 4 ounces per square foot in excess of the outside atmospheric pressure at the time."

The system is named after its inventor, a Glasgow engineer. "Mr. Henman takes no credit for the method by which a suitable supply of air is cleansed, tempered, humidified, and propelled into the buildings, but acknowledges his indebtedness to Mr. Key for the assistance he has rendered in working out his ideas in connection with the methods he adopts. It is simply proposed that air so cleansed, tempered, and humidified should be propelled through wedged-shaped openings in the ceilings, and by means of a simple form of spreader evenly distributed throughout the wards and corridors. The feature which Mr. Henman claims to be a novelty is the placing of a screen (somewhat similar to those employed by Mr. Key at the air-intake) at the head of every bed, and keeping the same charged with a disinfecting fluid. An outlet flue will be provided at the back of each screen, so that, as fresh air is constantly being propelled into the ward, an equal quantity will be forced through the screens, all other outlets being stopped; consequently, almost immediately the air becomes contaminated, it will again be purified, even before it actually leaves the apartment, and, thus purified, will pass up the flues into the open air."

The charging of the screens with the disinfecting solution is done by a pump connected with small cisterns, and driven by the same power that impels the fan. Steam-pipe coils will be employed to warm the air delivered into the wards in cold weather. "As regards the cost of the method proposed, the necessary apparatus is stated to be quite inexpensive and easily applied, and Mr. Henman is prepared to show that buildings can be erected and equipped at considerably less cost than is now expended upon hospitals relying only upon the ordinary means for ventilation, without any appliance for purifying the air emitted."

Plans for Home Grounds.

A CORRESPONDENT of *Garden and Forest* wrote to that journal that he had 6 sq. acres of ground fronting on a river and gently sloping back from the stream. With these meager data supplied, he asked where would be the best place on the ground for erecting a dwelling-house, and requested that a book of plans for laying out the grounds be sent to him. Whereupon the journal named (June 19) makes this request a text for an editorial on the subject indicated by the title.

Notwithstanding the fact that the person asking for information shows by the manner of asking that he has the crudest possible ideas relative to the requirements, his case is considered "more hopeful" than that of "the average American citizen." The latter would walk about the place and "decide on the location of his future dwelling without any serious study as to how his house, with the other necessary buildings, the stable-yard, the carriage-approach, and other foundation-features of the scheme, could be most conveniently arranged, while the thought of preserving the natural beauties of the place would hardly enter his mind; and, if it was suggested that these beauties might be enhanced by careful treatment, he would probably decide that all such consideration could be postponed until his buildings were completed."

Published plans have small value except as they illustrate some special problem. It is always safe to begin with "a thorough investigation of the resources of any given property from a landscape point of view. It may have an attractive, distinct prospect, and a noble sky-line in some direction. It may be possible to command a view of a stretch of water which holds the light of the sky and brightens every sur-

rounding object. The property may contain trees which are impressive from their size, age, and dignity of aspect. There will always be something in the contour of the land itself, in the vegetation that it contains, or in the outlook into the territory beyond its boundaries, which will furnish a motive for the intelligent treatment of a place. With such a reasonable end in view, the designer will pursue his purpose thoughtfully, and will escape the dangers of those who only have a vague and misty notion that they want to make a pretty picture. Of course, this leading motive will vary in every instance. One who is developing a place on the banks of a Florida river would hardly be successful if he were controlled by the same ideas as if he were planning a homestead in a mountain glen and amid the grandeur of mountain scenery. But in either case the effort would be to discover and unfold the charm which is peculiar to the spot,—that is, to develop its native beauty rather than to trick it out with some imported ornament."

As to the average American citizen's attempt to make a thing of beauty out of a spot of land, the want of success is usually the most conspicuous outcome. "No one but a genuine artist can discern the latent and possible beauties of any piece of ground, and no one but a constructive artist, in the best sense of the word, can adjust a place to the practical necessities of every-day life, and yet, by turning difficulties into opportunities, can preserve its essential and poetic charm. It comes to this at last. The laymen who endeavor to develop their grounds on purely natural lines, with an eye to preserving the spirit and sentiment of the place, whether it be of wildwood, or seashore, or mountain gorge, or smiling meadows and cultivated farm land, may fail, and probably will fail, of the very highest attainment. And yet so long as they treat nature with reverence, or even with respect, they will not make such pretentious failures as do they whose first effort is to obliterate everything that is native and natural because it is common, in order to make a lawn of such a shape as they have seen in a map, and dress it in such exotic finery as is usually named in the planting list which accompanies the ready-made plan."

Designing Radiators.

IN a paper published in *Domestic Engineering* Mr. Leicester Allen criticises the modern tendency to load steam and hot-water radiators with ornament in relief, and also some defects in design which reduce efficiency as compared with cost. "Excessive height in proportion to base is one of the features deprecated. One reason assigned for this feature in design is that a radiator whose height is large, as compared with the size of its base, can be manufactured more cheaply per square foot of surface than lower ones, and radiators are sold with reference to their rated surface in square feet. By such disproportion the mean efficiency of the surface is reduced. Another reason is that the same amount of surface in a tall radiator occupies less floor-space than a lower one having the same number of square feet of surface, and, especially in cities, it is desirable to economize floor-space.

"All who are familiar with the principles of the transmission of heat to air and surrounding objects by the surfaces of metal pipes must admit that the higher a vertical pipe is the less efficient it becomes, considered as a heat-imparting device." Another defect to which attention is directed, and which has been exaggerated "in the struggle to obtain radiators that shall look well in apartments, is the opposition to each other of broad surfaces at near distances." Now, while it is readily admitted that the action of contact of air flowing over the surface of a radiator is in all cases very much greater in its effect upon heat-transmission than the action of radiation, properly so called, still, the latter, in a well-designed radiator, can be made to aid materially in the total effect; and this is proved by the fact that, when radiators are covered by screens, perforated or otherwise, their effectiveness is much reduced, notwithstanding the air has as free access to the heated surface as before."

A criticism of the odd and contorted

shapes met with in some designs is also made. "Such a radiator may look pretty well when nicely bronzed and standing on the floor of a salesroom; but, in use, I should think it would be altogether such a nuisance as to grievously burden the hearts of good housekeepers. These creases and configurations are just the things to catch and hold dust, and the cleaning of fifteen or twenty of radiators of this kind in a first-class dwelling would make a neat woman with a rather high temper unpleasant company at times. The same thing holds with a stove; a plain one is easily kept black and shiny; one spattered all over with ornaments, such as mouldings, rosettes, and filagree work, gives double the amount of trouble. Speaking from experience checked by theoretical principles, I believe the best design for a steam or hot-water radiator is one that has very little ornament in relief; one that has a height not exceeding 30 in.; one that will expose to air and surrounding objects the maximum of radiating surface, properly so considered; and one that, though it may cost 3 to 4 cents per foot more than that of a radiator designed only to catch the eye of the purchaser by its ornate appearance while violating the laws of heat transmission, will be cheaper in the end to the purchaser than radiators of the kind criticised." Taken by and large, a low, flat, pipe-coil is probably the most efficient radiator ever yet devised; but it occupies so much space that it is not much used.

The Denayrouse Electrical Gas Burner.

ACCORDING to *Electrical Engineering*, quite a sensation was created a week or two ago by Professor Vivian Lewes informing the members of the Gas Institute at Edinburgh that a French scientist, M. Denayrouse, had discovered a means of increasing the illuminating power of gas something like fifteen times. Prof. Lewes had been made aware of the discovery during a visit to M. Denayrouse in Paris, and he had obtained permission to experiment with the new method of gas lighting and to make a communication upon the subject to the Edinburgh meeting.

In this invention M. Denayrouse had first been struck with the idea of applying the principle of the blow-pipe to the gas burner. He employs a lamp with a spherical shaped metallic body, and an incandescent mantle. In the body of the lamp is placed a very small dynamo, working a ventilator and receiving the current from a couple of small accumulators. The electrical energy required is exceedingly small, and is said to be only about 1-3 volt and 1-10 ampere. This, however, is quite sufficient to force a current of air through the mantle and to cause the gas to burn with remarkable brilliancy.

According to M. Mellet, the lamp has a density of 35 to 40 carcels, and consumes 7 litres of gas per carcel. Prof. Lewes had, however, been shown a lamp of 80 carcels (about 800 C. P.), and he was convinced that the light was quite as brilliant as an arc lamp.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*32401. Uninhabitable Houses in City Slums.—Some of the Causes, and a Remedy. William Stevenson (Eng Mag-Aug.) 3000 w.

*32404. Illuminating Gas for Heating Purposes.—A Coming Revolution Predicted. Ill. Frederick Siemens (Eng Mag-Aug.) 3000 w.

32464. Ventilation of Hospitals. From *The Architect* (Am Arch-June 8.) 2200 w.

*32468. The Dwelling House From a Sanitary Point of View. Isaac Young (*Plumb & Dec*-June 1.) 4500 w.

*32520. Designing Radiators. Leicester Allen (Dom Eng-June.) 1200 w.

32614. Plans for Home Grounds. Editorial (Gar & For-June 19.) 1200 w.

32735. The House Heating Boiler Question. How to Regulate. John W. Mills (Met Work-June 22.) 1500 w.

32738. A Combined Steam and Hot-Water Residence Heating Plant. Ill. (Eng Rec-June 22.) 1400 w.

*32755. The Ventilation of Buildings. John H. Kellogg (*Ill Car & Build*-June 14.) 2000 w.

*32884. The Drainage System of the Houses of Parliament. Ill. (*Eng*-June 21.) 2000 w.

Serials.

29334. Technical Subjects That Plumbers Should Know. F. Dye (*Plumb & Dec*-Began April—3 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Electricity on the Railroads.

WITHIN the past few weeks a number of very notable contributions have been made to the literature dealing with the present and future application of electricity on railroads. Besides the well-considered and valuable paper of Mr. F. J. Sprague, which appeared in the last number of this magazine, Mr. H. G. Prout has an essay of scarcely less importance in the *Independent* of June 6, Joseph Wetzler in *Scribner's Magazine* for May treats the subject in a popular way, and, finally, Dr. Louis Duncan, the newly-elected president of the American Institute of Electrical Engineers, gave an inaugural address at the recent meeting of that body at Niagara Falls, in which the matter was discussed with great care from the standpoint of present practice. Further observations were made at the same meeting by Mr. C. P. Steinmetz, which, together with Dr. Duncan's address, may be found in the *Electrical World* of July 5. When this subject is discussed at length by those in every way qualified to express an opinion of real value, it is worth while to listen to what they have to say, especially when we find a railroad expert like Mr. Prout in substantial agreement with two such eminent electrical experts as Messrs. Sprague and Duncan, not only as to the essential facts of the present situation, but also as to the probable outcome of future development. Commenting on these papers, the *Railroad Gazette* of July 5 says in an editorial: "We advise railroad officers and directors to read this [Dr. Duncan's] address carefully, for it is very able and temperate. These are days when those who are responsible for the present and future prosperity of the railroads cannot sleep on their oars. It is their business to learn especially the possible uses and possible limits of electricity as a 'mode of motion' on railroads, and to learn this as fast as they can. As Dr. Duncan says, the safety of the steam roads is to make of electricity an ally instead of an enemy, and this before it is too late. A great deal of money has been wasted, and a great deal more will be wasted, in building electric railroads. A great deal of harm has been done by these railroads to the steam railroads, and more will be done; and, unfortunately, their capacity for harm is not gaged by the profitableness or the usefulness of these electric railroads. It long ago became an axiom that a bankrupt road is the most dangerous competitor."

All these authorities are in substantial accord in saying that it is a fundamental principle of economy in electrical transportation that the movement shall be in small and frequent units. As Dr. Duncan briefly and forcibly puts it: "The tendency of passenger transportation on the steam lines has been in the direction of the greatest electrical economy, while the tendency of the freight transportation has been in the direction of the least electrical economy." The conclusion to be drawn is that in certain fields of operation the electric service is likely within a few years to monopolize most of the passenger traffic,—to wit, all municipal or rapid-transit lines, whether above, upon, or below the surface all suburban service, within some limited, but not yet determinate, distance from the large cities (say 20 miles); interurban service between cities and large towns not too far apart; and most of the local business between smaller towns within the same limit, where the lines are permitted to occupy the surface of the public highways. So far, there is but little difference of opinion among these authorities, but, when it comes to the question of heavy express-train service between large cities, there appears to be considerable difference of opinion. Dr. Duncan and Mr. Wetzler are apparently much more sanguine of the future possibilities in this direction than are Mr. Sprague and Mr. Prout, neither of whom believe that

the steam locomotive is likely to be very soon superseded either for freight or heavy and fast express service. Dr. Duncan gives a very complete description of the Baltimore plant, in which electric locomotives of massive construction, weighing 95 tons and having eight driving-wheels, are to be used to haul the ordinary steam trains, locomotive and all, through the tunnel under that city. He says of this plant that, if it proves successful, it will open a limited, but important, field for the introduction of large electric locomotives. It may, we think, well be doubted whether compressed-air would not perform this particular service with equal efficiency and at a far less cost than electricity.

The operation of "trolleyizing" the Nantasket Beach branch of the New York, New Haven & Hartford Railroad has attracted an amount of attention among newspaper writers which is apparently altogether out of proportion to its technical importance. The conditions are substantially those of a suburban line. It is about 7 miles long and has at present ten stations, though provision will be made for numerous additional stops by the way-trains. Motor cars and trailers will be used. The principal feature about this road is its careful and thorough construction, although it is stated, among other things, that the wooden poles are to be depended upon for the insulation of the conductors, no special insulators being used, which looks like a piece of superfluous folly. Many interesting particulars regarding the construction and arrangement of the permanent way and the electrical plant are given in the *Railroad Gazette* (June 14) and in the *Electrical Engineer* (July 3). An experimental run was made in the latter part of June, during which, according to newspaper reports, a speed of over 80 miles per hour was attained, which is possible, though not probable.

Did Reis Invent the Telephone?

IT is not likely to be an easy matter to reverse the verdict of the world that the true inventor of the speaking telephone is he who first gave it to the world in a form in which it possessed a sufficient degree of utility to be of at least some commercial benefit. One of the people who are obviously dissatisfied with this verdict is the well-known physicist, Professor A. E. Dolbear of Tufts College, who, in an article in the *Electrical Engineer* (June 19), once more advocates the not unfamiliar claims of Phillipp Reis of Germany to that distinction. He says: "That which makes the transmitter of to-day better than the Reis transmitter is the substitution of hard carbon, and nothing else, in the same place and for the same purpose for which platinum was used by Reis. If Reis had chanced to employ such carbon in the place of platinum, he would have had a good speaking telephone." So much may doubtless be granted, but, when the writer goes on to say that the first introduction of carbon was due to Professor Hughes of London, who gave it to the world, and that "the legatee failed to receive the legacy through crafty legality," he states that which a very little research would have shown—to put it mildly—to be a mistake. At least as early as September, 1877, the writer of this received a modest printed circular, setting forth the results of certain experiments made with carbon contacts by Emile Berliner; and the records of the patent office show that the same inventor, on September 10, 1877, filed a drawing of an apparatus showing a vibratory electrode carrying a bit of hard carbon in loose contact with a vibratory metal electrode. The experiments of Hughes were not made until January, 1878, and were not given to the public until May following. Of course it may be fairly assumed that Hughes knew nothing of what Berliner had done, and, naturally supposing himself to be the first inventor, freely undertook to give to the world that which, as it turned out, was, in fact, not his to give. Professor Dolbear also states that Mr. Yates of Dublin University placed a drop of water between the terminals of the transmitter, and "succeeded in transmitting speech perfectly, as one can see would be the case"; and he makes complaint that in the patent litigation over the telephone the testimony of witnesses to the fact was

excluded. Of course it was; such is and ought to be the law. How many patents would ever be sustained if witnesses in behalf of infringers were permitted to testify from recollection as to the operation of a chance experiment witnessed years before, utterly unsupported by contemporaneous records? Professor Dolbear further asserts that, "when the [Reis] transmitter is spoken to gently, it transmits fairly well, in spite of the breaks which may occur." If our memory serves us, Professor Dolbear testified in one of the telephone suits some years ago that he had frequently talked through a fac-simile of Reis's transmitter, and had heard words and even whole sentences. But, when challenged by the opposing counsel to do the same thing in the presence of witnesses, using a Reis receiver, he found it utterly impossible, even after elaborate preparation, to transmit a single sentence intelligibly. All these experiments, including a stenographic report of every word uttered into the transmitter, and heard or not heard at the receiver, are given in the court records. The truth is that neither the instruments of Reis or those of Yates were of the slightest commercial utility. They were interesting and instructive laboratory experimental apparatus, but they were not telephones. The verdict of the world upon a question of priority of invention is not often, and perhaps not even generally, right, but in the case of the telephone nothing whatever has thus far been presented which appears to call for a reconsideration of the reiterated verdict of the federal courts.

The Niagara Plans.

IT is an open secret that there has been a great deal of controversy over the authorship of the apparently successful electrical plans which have been adopted by the Niagara Company. It will be remembered that a suit was brought against that concern by Professor Rowland some time since for expert services, as a result of which that gentleman obtained a verdict for a considerable amount of money. In the *Electrical Engineer* (July 3) Professor Rowland has a communication in criticism of an interview with Professor George Forbes, reported in an English technical journal, which brings to light a number of very interesting facts. It seems that in September, 1892, Professor Forbes handed in a report containing his final recommendations to the Niagara Company as to the design of the electrical machinery of the famous power-plant, which may be summarized as follows: a two-phase alternating system, the dynamo giving a current of 10,000 volts and 8.3 periods per second; weight of revolving parts not to exceed 10 tons, and no iron in the armature. Professor Rowland states that, being called upon for a critical opinion of this design, he condemned it *in toto*, with the sole exception of the two-phase feature, and expressed the opinion that Professor Forbes's dynamo would not last a month, if it did a week, and now adds that the system at Niagara does not contain a single one of the features which he condemned, while, on the contrary, the features which he recommended are those in use at Niagara to-day "in spite of Professor Forbes's opposition to the very last." Professor Rowland says the revolving parts are heavy; the armature contains iron, step-up transformers are used, and a frequency of 25 periods per second has been adopted. He adds (presumably referring to the modifications introduced by the engineers of the Westinghouse Company): "My 'not less than 25 tons' for the revolving parts have become 40 tons, and my period of 42 or 33 has gone down to 25, and my revolving armature has become revolving magnets. As to whether the changes are for the better, time alone can show. As to whether 40 tons can be successfully revolved at two hundred and fifty turns per minute, a short time will decide." Replying to certain criticisms which have been made in reference to the professional propriety of a scientist bringing suit to collect pay for his services, Professor Rowland very justly and pertinently observes: "Everybody who knows me at all knows that money forms a very small portion among the objects that I seek. But, when men wish me to take my mind from those objects which I

love, and devote it to their private money-making pursuits, I am then entitled to be compensated at the same rate as a first-class lawyer or physician. Furthermore, I have no right to degrade the profession of a man of science by undervaluing my own services. Let everybody recognize that the successful pursuit of science requires quite as much brains and knowledge as that of law, and that a scientific error often equals in disastrous consequences a legal error." In all of which most right-thinking persons will cordially agree with Professor Rowland.

The Telegraph in Mexico.

IN the *Electrical Engineer* (May 29) Mr. Geo. H. Guy has a very interesting article descriptive of the governmental telegraphic system of our sister republic. No longer ago than 1885 the telegraphic service of Mexico was in the most wretched condition imaginable, being in the hands of unscrupulous politicians who, as the saying goes, "worked it for all it was worth." Finally President Diaz determined to include the telegraph in the plans for civil-service reform which have signalized his progressive administration. Mr. Saturino Islas, who had mastered every detail of modern telegraphy in the United States, was the man selected to reorganize the service, and was appointed director-general of telegraphs and invested with almost absolute authority. Sweeping changes were made in the staff, and the lines were thoroughly reconstructed and equipped with American-made instruments. The system now extends from the Gulf to the Pacific and from the frontiers of the United States to those of Guatemala, comprising 41,868 kilometers of line and 306 stations. The tariff is adjusted on a concentric zone system, the minimum rate being 20 cents for ten words and a maximum of $2. The lower charge covers the city of Mexico and a radius of 180 kilometers; beyond that there is an increase of 20 cents for each 180 kilometers or fraction thereof. Each office has a map on which are plotted nine circles having that office as their common center; a simple glance at the map informs the sender in what zone his message is to be delivered, and he can compute the tariff for himself. The Morse system is used throughout; duplex apparatus is installed in twenty offices, and twenty-five offices are equipped with automatic repeaters. The gross receipts for messages during the last fiscal year were a little over $1,000,000.

Electricity in a Great Library.

THE new public library in Boston may fairly rank among the most notable institutions in the United States. One of its most unique features is the electric service, of which a very full description is given in the *Electrical Engineer* (June 5). The handling, delivery, and distribution of books is carried out by means of an apparatus of the general type of the well-known store service system. An attendant has only to pick out the book wanted, place it in a little car on a siding, and switch the car on to the main line, from which it runs at the rate of 500 ft. per minute to a special elevator, which automatically drops to the delivery room, waits there until the empty car comes back, and then delivers it to a return track leading to the siding from which it started. There are six stories,—or stacks, as they are termed,—each of which has a special carrier service and a special elevator. The track is of 8-in. gage; the cars are of wire, and will carry from 10 to 30 lbs. of books at each trip. The whole is operated by a 10 h. p. motor. The same motor operates a pneumatic-tube system, by which tickets, cards, etc., may be sent from one part of the building to another. The whole edifice is thoroughly ventilated by a large fan driven by a 50-h. p. motor. The switchboard is so arranged that the service within the building can be operated, either from its own plant or from the street lines of the Edison Electric Illuminating Company. The building is lighted by 3500 incandescent lamps, divided into five groups. The steam plant of the building consists of two tandem compound engines of 150 h.p. each,—sufficient to light a town of 5000 inhabitants. The exhaust-steam will be utilized in heating the building in cold

weather. Apparently no pains have been spared to make all the appliances as complete as possible.

Municipal Electricity in Chicago.

IN the *Western Electrician* (July 6) may be found some decidedly spicy editorial comments upon the much-lauded municipal electric-lighting system of Chicago. It will be remembered that, after this plant had been in operation a year or two, an apparently official announcement was published far and wide that that fortunate city was getting its streets lighted at the rate of $73 per lamp per year for a full-arc all-night service,—a statement which every well-informed electrical engineer knew to be necessarily untrue. The Chicago "figures" were quoted everywhere as gospel by the advocates of municipal ownership, and made more than enough trouble in various places for the owners of private plants furnishing street-lights in cities. In 1890 Mr. M. J. Francisco made an investigation on his own account,—as no itemized information could be got from the city electrician of Chicago,—and reached the conclusion that the real cost could not be less than $190 per year per lamp, exclusive of the salaries of the electrician and superintendent, and the expenses due to accidents. In 1890 a committee of Milwaukee aldermen visited Chicago for the express purpose of ascertaining the cost of municipal lighting, but met with very little success. The city electrician positively refused to give any information whatever, and, according to the Milwaukee report, informed the committee that the affairs of the plant were in such a state of chaos that he could not give even an approximate estimate of the actual cost. All this time central-station managers throughout the country, who were seeking city contracts, were continually confronted with the question: "Why can't you furnish light at $73 per lamp per year, as they do in Chicago?" It is safe to say that we shall never get a statement from the Chicago electrician which will inform us precisely how arc-lights can be run at a net cost of $73 per lamp per annum in a city of that size.

The Selection of Telegraph Operators.

AT the recent meeting of railroad telegraph superintendents in Montreal, the question of the selection and training of operators received considerable attention, a special paper on the subject having been read by R. W. Pope, while incidental consideration was given it in other papers, as appears from the reports given in the *Railroad Gazette* of June 21. Inasmuch as nearly all the commercial as well as the railroad operators begin their career in railroad offices, the responsibility of selecting good material falls in the first instance upon the railroad superintendent. Mr. Pope urged that it would be perfectly feasible to establish and enforce a rule that intending students or assistants shall first be examined and reported upon, with a view of finding out something about their character and their adaptability to the business. It appears from a paper read at the same meeting by Mr. Torrey, superintendent of telegraph of the Michigan Central Railroad, that this practice is in force on his road, and, if we are not mistaken, has been ever since the time, now 30 years ago, when M. D. Woodford occupied the same position. The Michigan Central has always been noted for the high standard of efficiency and technical merits of its telegraphic service,—a fact which may be easily accounted for under the circumstances. The great fault in the telegraphic service, both railroad and commercial, is the too prevalent lack of any feeling of responsibility on the part of the operators beyond that of working a certain number of hours per day and getting paid for it. In old times things were very different. On the lines of the Magnetic Telegraph Company and of the New York and Boston Telegraphic Association, and probably others of the pioneer lines 50 years ago, the greatest care was taken in the selection of operators, and they were sworn into office with as much formality as is the president of the United States. This may look to modern eyes, a little absurd, but it was not so. The candidate for telegraphic honors at least had it impressed upon his mind that he was undertaking a serious responsibility, whereas under the present system,

or rather lack of system, two-thirds of the telegraphic service of the country is performed by a herd of immature boys and girls, who, however expert they may be in working the apparatus, are as far as possible from having any adequate sense of the importance of the interests confided to their care. It is all wrong, and is a matter which needs to be radically reformed.

Modern Electric-Power Transmission.

ONE of the most interesting papers read at the recent annual meeting of the electrical engineers at Niagara was that of G. H. Winslow, describing the electric-transmission plant at Pomona, Cal., which is chiefly remarkable for the long distance over which the energy is transported and the high electrical pressure used, in both of which respects it is, as a commercial apparatus, almost unique. It comprises a Pelton water-power plant working under 390 ft. effective head and fitted with a differential governor. The present generators are single-phase alternators of 120 k. w., running at 7,200 alternations, and are two in number. The units of both raising and reducing converters are of 6 k. w. capacity, and are kept cool by immersion in oil. The ratio of transformation is 1000: 450, so that in a bank of twenty converters the dynamo pressure required to produce 10,000 volts in the line is 1110 volts on open circuit and 1140 under load. There are two independent transmission circuits, each of two No. 7 copper wires. One, 13¾ miles long, supplies Pomona, and the other, 28¾ miles long, supplies San Bernardino. Double-petticoat flint glass insulators are used. The sub-stations are small brick buildings, and the main circuits are connected direct to the reducing converters without switches or other appliances. Still-well regulators are placed at the sub-stations, instead of at the power-house as in the usual arrangement. The distribution from the sub-stations is similar to that ordinarily used with a 1000-volt alternating dynamo. No attendance is required at the sub-stations, all necessary regulation being effected by the attendant at the power house. The average efficiency of the Pomona circuit is found by test to be about 75 per cent., and an efficiency of over 60 per cent. was attained in an experimental transmission of 100 h. p. to San Bernardino, *via* Pomona,—a distance of 42.5 miles. No interruption of service has occurred since the plant began working at 10,000 volts on February 16, 1893.

Electric Conduit Railways.

IN the June number of this magazine some account was given of the conduit system of electrical distribution about to be tried on the Lenox avenue line of the Metropolitan Traction Company in New York city. This is now in operation, with apparently successful results, and illustrated descriptions giving many interesting details of the plant are published in the current technical journals, notably in the *Electrical Engineer* (July 5). In the *Electrical World* (June 22) may be found a partial description of another conduit system recently offered to the public by the Westinghouse Company, which presents some features of apparent superiority. Groups of metallic contact-pins are inserted in the pavement, each 5 in. in diameter and projecting about ½ in. above the surface. These are rubbed by collector-bars attached to the cars, as they pass over them, and, by means of switches placed in switch-boxes set in the pavement, are connected successively with the insulated feeder cables. Each car carries a small storage-battery, and, as the collector bars slide over the contacts, its current comes into play to operate the switches by an electro-magnetic device. Thus only those contacts which are being passed over by the car are at any time in connection with the source of electric supply. The system is not altogether an untried one, it having been in operation for some time in Washington, D. C., but, as now presented, has material improvements in many of its details. Its first cost, though greater than that of the overhead trolley, must be much less than that of such a conduit system as that of the Lenox avenue line, heretofore referred to. Appearances indicate that the advent of a practicable system of underground distribution for street railways will not be much longer a thing of the future.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

32478. Coal Consumption in an Edison Station. Type of 1890 (Elec Eng-June 12.) 300 w.

32539 The Belfast (Ireland) Municipal Electric Station. Ill. (Pro Age-June 15.) 1100 w.

32671. Light and Electrification. Oliver J. Lodge (Sci Am Sup-June 22) 3000 w.

32689. Boilers of the City Electric Lighting Plant of Detroit, Mich. Ill. (Eng News-June 20.) 700 w.

32731. The Electric Lighting of the Baltic Canal. Ill. Carl Coerper (Elec Wld-June 22.) 2500 w.

32851. A Central Station With Three-Phased Current Generators. Ill. G. H. Zahn (W Elec-June 29.) 1500 w.

*32898. The Robertson Incandescent Lamp. Ill. (*Elec Eng*-June 21.) 2000 w.

*32906. On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light. W. E. Wilson (*Elect'n*-June 21.) 1000 w.

*32909. Dependence of the Photo-Electric Current upon the Azimuth and the Angle of Incidence of the Light. J. Elster and H. Geitel (*Elect'n*-June 21.) 1500 w.

*33054. The Blondel Lumen-Meter. Ill. (*Elec Eng*-June 28.) 1100 w.

Power.

32436. Electric Transmission—When It Will Pay in Mill Work (Bos Jour Com-June 8.) 700 w.

32481. A Radical Departure in Dynamo Design, and the First Plant Installed. Ill. (Elec Ind-June.) 1300 w.

†32500. Electric Power Transmission. F. Jarvis Patten (New Sci Rev-April.) 2400 w.

32519. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton (Elec Age-June 15.) 1000 w.

32697. The Electric Accumulator. Ill. J. B. Stewart (Elec Age-June 22.) 2000 w.

*32721. Economy and Accumulators. Ill. Ed. W. Cowan (*Elect'n*-June 14.) 1100 w.

*32726. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton (*Elec Rev*-June 14.) 1200 w.

*32728. The Continuous Current Dynamos of F. Balas and L. Couffinhal. Ill. P. Girault (*Elec Eng*-June 14.) 1400 w.

32769. The Maximum Possible Efficiency of Galvanic Batteries. Henry Morton, in Cassier's Mag. (Am Gas Lgt Jour-June 24) 1100 w.

32784. The Work that Has Been Done at Niagara. Ill. (Elec Eng-June 26.) 2500 w.

32833. Storage Batteries. C. F. Annett (Elec Age-June 29.) 900 w.

32840 The Testing of Alternating-Current Dynamos. H. Behn-Eschenburg (Elec Wld-June 29.) 2000 w.

32842. Polyphase Currents and Motors (Elec Wld-June 29) 1800 w.

*32908. Polyphase Motor Calculations. Hermann Cahen (*Elect'n*-June 21.) 2200 w.

*33046. Multiple Current Dynamos. Ill. Rankin Kennedy (*Elec Rev*-June 28.) 1200 w.

*33053. Rotary-Current and Alternating-Current Dynamos of the Algemeine Electricitats-Gesellschaft. Ill. M. Von Dolivo-Dobrowolsky (*Elec Eng*-June 28.) 1700 w.

Telephony and Telegraphy.

32479. Municipal Telephony. Editorial (Elec Eng-June 12.) 2000 w.

32482. An Historic Sketch of the Atlantic Cable. Frank Hallenbeck (Elec Ind-June.) 800 w.

†32495. The World's Cables. Moses P. Handy (New Sci Rev-Jan.) 3800 w.

32509. Telephone Service: The Relative Cost to the User. Fred De Land (Elec Engng-June.) 3300 w.

32654. Reis's Place in Telephony. A. E. Dolbear (Elec Eng-June 19.) 1200 w.

32679. The Projectors of the Atlantic Cable. Abstract of Speech by Chauncey M. Depew (Elec Rev-June 19.) 1500 w.

32681. Opinion of the United States Circuit Court of Appeals in the Berliner Case (Elec Rev-June 19.) 16000 w.

32834. Remedies for Disturbing or Interfering Currents on Telegraph and Telephone Circuits. Thomas D. Lockwood (Elec Age-June 29.) 2000 w.

32860. Modern Telephone Exchange Systems. Ill. George P. Low (Elec Jour-July.) 13500 w.

Miscellany.

32461. Study of Earth Currents. L. Palmieri (Elec Rev-June 12.) 900 w.

†32494. "What Electricity Is." I. Compiled by Mrs. Bloomfield Moore. II. C. J. Reed. III. Henry Clay (New Sci Rev-Jan.) 8000 w.

†32496. Pre-Scientific Electricity. Horace Hayden, Jr. (New Sci Rev-Jan.) 4000 w.

32522. On the Theory of Units. Townsend Wolcott (Elec Wld-June 15.) 2500 w.

32524. The Output of Polyphase Generators and Rotary Transformers. Ralph D. Mershon (Elec Wld-June 15.) 2800 w.

32525. Some Work on Magnetic Hysteresis. Ill. Frank Holden (Elec Wld-June 15.) 1000 w.

*32548. A 30000 Volt Transformer. H. P. Plumb (Sib Jour Eng-June.) 700 w.

*32549. Hysteresis Due to Magnetic Rotation. Floyd G. Ten Broeck and H. F. Schoenborn, Jr. (Sib Jour Eng-June.) 900 w.

*32551. Insulating Properties of Oils. A. C. Bell (Sib Jour Eng-June.) 2000 w.

We supply copies of these articles. See introductory.

*32576. Ozone and Nitrous Compounds. E. Andreoli (*Elec Rev*-June 7.) 900 w.

*32591. The Effects of Lightning Discharges on Underground Cables. Ill. C. S. Du Riche Preller (*Elect'n*-June 7.) 2000 w.

*32592. On the Resistance of Galvanic Elements. Dr. Paul Schoop (*Elect'n*-June 7.) 1000 w.

*32594. Electric Discharge Through Gases. Ill. J. J. Thomson (*Elect'n*-June 7.) 3400 w.

*32595. The Electrical Measurement of Starlight. G. M. Minchin (*Elect'n*-June 7.) 1500 w.

*32600. The Electrical Laboratory of the City of London Commission of Sewers. Ill. (*Elec Eng*-June 7.) 2000 w.

*32601. The Magnetic Survey of the United Kingdom. A. W. Rucker (*Elec Eng*-June 7.) 1700 w.

*32602. Some Physiological Effects Experienced in Contact with Live Alternating Current Circuits. Ludwig Gutmann, in Electric Power (*Elec Eng*-June 7.) 1500 w.

†32631. Tests of a Combined Electric Light and Electric Railway Station. Dugald C. Jackson and Arthur W. Richter (Am Soc Mech Eng-June.) 3000 w.

32655. The Interior Conduit and Insulation Company: Its Products and Manufacturing Methods. Ill. (Elec Eng-June 19) 6500 w.

32678. The Three-Wire System—No Longer Necessary. Ill. (Elec-June 19.) 1800 w.

32838. Dimensional Formulæ and the Theory of Units. R. A. Fessenden (Elec Wld-June 29.) 2200 w.

32853. Popular Errors About Electricity. C. C. Haskins (W Elec-June 29.) 1400 w.

32861. The Efficiencies of Electric Plants. Sydney Sprout (Elec Jour-July.) 700 w.

32862. On the Field of Operations of an Electrical Engineer. E. J. Molera (Elec Jour-July.) 4000 w.

*32917. The Clark Cell When Producing a Current. S. Skinner (*Elec Rev*-June 21.) 800 w.

*33042. Safety Regulations for Large Installations. Proposed by the German Electrotechnical Societies. (*Elec Rev*-June 28.) 1400 w.

*33045. On the Variation in Capacity of an Electrostatic Voltmeter. Albert Campbell (*Elec Rev*-June 28.) 800 w.

*33065. The Electro-Chemical Reactions in Secondary Cells. W. R. Cooper (*Elect'n*-June 28.) 1200 w.

*33069. A New Method of Measuring Specific Inductive Capacity. Albert Nodon (*Elec'n*-June 28.) 700 w.

Serials.

6515. Notes on Submarine Cable Work. H. D. Wilkinson (*Elect'n*-Began Sept. 2, 1892—19 parts to date—30 cts. each).

22131. The Incandescence Lamp. A. Bainville (*Elec Rev*-Began May 11, 1894—10 parts to date—30 cts. each).

23866. Electrodynamic Machinery. Edwin J. Houston and A. E. Kennelly (Elec Wld-Began July 21, 1894—39 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (Elec Age-Began Aug. 25, 1894—32 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*-Began Oct. 5, 1894—39 parts to date—30 cts. each).

27371. The Electric Light. Henry Stooke (*Ill Car & Build*-Began Nov. 23, 1894—42 parts to date—30 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*-Began Feb. 1—19 parts to date—30 cts. each).

30872. Telephony. Ill. V. Weitlisbach (Elec Engng-Began April—3 parts to date—15 cts. each).

31284. Electric Lighting of Trains. Ill. R. W. Weekes (*Elec Eng*-Began April 19—Ended June 28—5 parts—30 cts. each).

31344. Practical Telephony. Ill. James Bell and S. Wilson (*Elec*-Began April 19—11 parts to date—30 cts. each).

31586. Factory Practice in the Design and Construction of Dynamos. Ill. C. E. Woods (Elec Ind-Began May—2 parts to date—15 cts. each).

32038. Nikola Tesla and His Work. Anon. (*Ill Car & Build*-Began May 17—3 parts to date—30 cts. each).

32164. The Shops of the Westinghouse Electric and Manufacturing Company. Ill. (Eng Rec-Began June 1—2 parts to date—15 cts. each).

32463. The People's Lamp. Frank Parsons (Arena-Began June—1 part to date—45 cts).

32603. The Mechanical Principles of Electrical Engineering. H. B. Ransom (*Elec Eng*-Began June 7—Ended June 14—2 parts—30 cts. each).

32723. The Absolute Measurement of Electrical Resistance. J. V. Jones (*Elect'n*-Began June 14—Ended June 21—2 parts—30 cts. each).

32732. The Westinghouse Electric and Manufacturing Company's New Plant. Ill. (Elec Wld-Began June 22—2 parts to date—15 cts. each).

32783. The Shunt vs. the Differential Arc Lamp. E. R. Knowles (*Elec Eng*-Began June 26—1 part to date—30 cts).

32905. Wave Form Synthesis. James Mark Barr, Stanley Beeton, C. Percy Taylor (*Elect'n*-Began June 21—Ended June 28—2 parts—30 cts. each).

32918. The Theory of Three-phase Generators. Arthur Whitwell (*Elec Rev*-Began June 21—Ended June 2—2 parts—30 cts. each).

33066. Notes on Some Experiments with Electro-Magnetic Mechanism. P. V. McMahon (*Elect'n*-Began June 28—1 part to date—30 cts).

33067. Gas Engine Electric Supply Stations (*Elect'n*-Began June 28—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

How Free Silver Would Affect the United States.

THE perils that would threaten the United States were the advocates of free silver coinage to prevail are set forth clearly and tersely in a paper by Hon. Edward O. Leach, late director of the mint, in *The North American Review* for July. "The free coinage of silver under present conditions . . . . may be defined as the right of anyone to deposit silver of any kind at a mint of the United States, and have every 371¼ grains of pure silver (now worth in its uncoined state about 52 cents) stamped, free of charge, 'One Dollar,' which dollar shall be full legal-tender at its face value in the payment of debts and obligations of all kinds, public and private, in the United States."

The national dishonesty which such an act would involve at this time is then dealt with incisively. The first coinage act (1792) "aimed to approximate the commercial value" of silver and gold. Hamilton held the view that there could scarcely be a better rule than that legal values of the metals should approximate their market values. Jefferson held the same view. "In point of honesty there is no practical difference between stamping and issuing a coin with full debt-paying qualities as $1 which is really worth only 50 cents, and cutting a dollar in half and requiring every one to accept the half as a dollar."

But, passing the dishonesty of such an act, the immediate effect of it would be "to place our currency on a silver basis." Even leading advocates of free silver coinage now admit this. First there would be "a violent contraction of the currency by the withdrawal of gold coins and gold certificates from circulation. The stock of metallic and paper money in the United States is about $2,209,000,000, every dollar of which, under present standard, is as good as a gold dollar and practically interchangeable with gold. The law makes it the imperative duty of the secretary of the treasury to 'maintain the two metals on a parity with each other' and provides the necessary means to accomplish it,—the pledge of the public credit. With free silver coinage the obligation, both moral and legal, upon the government to 'maintain the two metals on a parity' would end. The immediate result would be the destruction of the parity, the separation of our currency between gold and silver, and the withdrawal of $676,000,000 of gold from circulation and use as money. This enormous contraction of the money which is the basis of our currency system would unsettle business, impair credits, destroy values, and produce the most tremendous financial disturbance which this country has ever witnessed.

"After the first shock, the effects of which no man can fully foresee, when values had adjusted themselves to existing conditions, a silver basis means that the paying power of our money in foreign exchanges would be depreciated to the commercial value of the silver in our dollars, whatever that may be. We have a perfect illustration close at hand in our near neighbor, Mexico, of a country on a settled silver basis, with unrestricted gold and silver coinage. The Mexican dollar, although it contains more silver than our dollar, has a purchasing power in foreign exchanges equal only to its commercial value as a bullion. The same is true of the currency of every country which is on a silver basis. There is no country in the world to day where silver is minted into legal-tender coins where gold circulates as money. The commercial relations between European countries and our own are more intimate to-day than were the relations between the States of the Union prior to the civil war. All Europe has practically the gold standard, and all international exchanges, whether with gold-standard or silver-standard countries, are settled on a gold basis. The great bulk of

the foreign commerce of the United States is with countries having the gold standard. During the last fiscal year we exported to Europe merchandise of the value of $700,000,000, while we imported from the same countries merchandise of the value of $295 000,000. Between countries which use the same metal as money there is a par of exchange which varies only within well-defined limits, regulated by the balance of trade. Between countries which use different metals as a measure of value there is at present no natural par, because of the fluctuations in the commercial value of the silver. Stability in the rates of exchange is of the very essence of commercial transactions, especially commercial transactions based on credit. Without this there is necessarily an uncertainty which it is impossible to eliminate, and which complicates and deters business transactions. In this lies the *permanent evil of a* silver basis for our money,—*the uncertainty and fluctuations in the value of our currency as measured by the world's standard, gold.* What the purchasing power of our currency in domestic transactions would be would depend upon conditions which no one can foresee or accurately forecast." Thus the United States would become "the dumping-ground of the world's silver." What would we gain? "If we should exchange our stock of gold for a stock of silver, cut loose from the standard of all the great commercial countries with whom we do business, and ally ourselves to Asiatic and South American monetary systems, what would we gain? One of two things would most certainly occur; either our gold would be hoarded by banks, trust companies, and individuals, or else would go abroad to pay for the silver shipped here for sale. In either case our currency would be depreciated and fluctuating in value to the embarrassment of business and the ultimate injury of the wage-earner. The basis of our currency would be changed from gold to silver, but whether the increase in the value of money—the panacea for all our industrial ills promised by free-silver advocates—would be considerable, or the price of silver be permanently increased, is open to serious doubt. Just as long as it was profitable to ship silver to the United States,—that is, just as long as it would bring a higher price here than elsewhere,—silver would come, but it would not come when the shipment ceased to be profitable. If silver ceased to come here because it was not profitable to ship it and receive payment in dollars whose purchasing power was only equal to the commercial value of the metal contained in them, where would be the gain in the volume of our currency?"

The assertion that the decline in prices of wheat, cotton, and other products is due to the disuse of silver as money is completely answered and its absurdity demonstrated. "The decline in the prices of staples could not have arisen from any scarcity of metallic money, for the reason that there is nearly double the amount of metallic money in use in the world to day that there was in 1860,—the official estimates of the coin stocks being $3.400,000,000 in 1860 against $8,021,000,000 in 1894 (Report of director of the mint, 1894, pages 44–55). Nor could it have arisen from disuse of silver money, for the reason that there is more silver in use in the world now than the entire stock of metallic money in 1860,—the figures for silver money being $4.055,000,000,000 in 1894 against a total metallic stock in 1860 of $3,400,000,000.

"In our own country, where prices have declined as much as elsewhere, it is a fact shown by treasury statements that we have not only more money in actual circulation than ever before, not excepting the flush times of the war, but vastly more silver money . . . . Indeed, there is no country where the amount of actual money has diminished in recent years, but, on the contrary, in addition to an increased stock of metallic and paper money, the effort of civilization and one of its most beneficial results, developed largely during the last 20 years, has been to minimize the use of actual money by providing substitutes in the shape of checks, drafts, bills of exchange, telegraphic transfers, and clearing-house settlements."

"It is sufficient to say that there is not

one of the great staple commodities which has fallen largely in price where such decline cannot be readily traced to circumstances affecting the demand and the supply of the article itself."

Free silver coinage "would replace the doubt of our ability to maintain gold payments by the certainty that we did not intend to. It would be a national disgrace as well as a national misfortune—which the people of this country will never submit to—to debase the money of this proud and prosperous republic to the standard of Mexico, South America, and Asiatic countries."

The Precious Metals — Appreciation and Depreciation.

THE above is the title of an article in *The Banker's Magazine* for June, by Mr. Edward Atkinson, which is in the nature of a criticism upon the use of terms employed in recent discussions of monometallism and bimetallism. Mr. Atkinson states that "in the discussion of the monetary question" the words "appreciation" and "depreciation" are used with reference to both gold and silver. This, he thinks, leads to confusion in thought.

"It is held, even by some of the most conspicuous authorities among those who desire that the gold standard shall be maintained, that gold has appreciated in recent years. It is proved that a lessening quantity of gold will command an increasing quantity of products, and that this fact proves appreciation. In this view no regard is paid to the changed conditions under which these products are made and distributed. It follows that, if the product had not increased in ratio to the labor employed, the inevitable consequence of this appreciation of gold would be to render the payment of all national debts and of all other long-deferred payments more and more onerous. It would render it necessary for railways and other corporations which had issued bonds payable at a long-deferred period to do more work at an increasing relative cost and at a lessening price, in order to meet the interest on the bonds and to pay the principal. The announcement of this view by prominent men who are known as monometallists has given to the advocates of what is called bimetallism one of the strongest levers with which to move public opinion.

"On the other hand, the most common, potent, and plausible theory which is put forward by the advocates of the so-called bimetallic policy is that silver has maintained about an even ratio with other commodities in relation to gold, that gold has become scarce and has appreciated to the injury of all who are indebted, and to the great disturbance of commerce."

A criticism of another common expression, "fatal fall in prices," which President E. B. Andrews of Brown University has rendered conspicuous, is also made. "This problem of appreciation or depreciation is one of the most difficult to analyze, and is one which it is almost impossible to put into statistical form. We may deal, however, with any of the accepted tables of the average wholesale prices of all important articles, as in Wright's 'Prices and Wages,' or of selected commodities, as in Sauerbeck's tables, of which the accuracy is admitted by all. We then unquestionably find that there has been a large reduction in the average of prices of most of the necessaries and comforts of life since 1873. On that ground it is urged that gold has become relatively scarce, that it has appreciated, and that hardships have ensued therefrom." Without making extended excerpts from the arguments made to substantiate the proposition that gold has not appreciated, but that products in general have depreciated, in price, we may state that through this line of reasoning the conclusion is reached that "no mere comparison of the prices of goods proves anything as to the relative abundance or scarcity of gold." As to the term "fatal fall in prices," in cotton and wheat, the two staples supposed by the school represented by Prof. Andrews to have suffered most by "the parting of the bullion value of silver and gold," Mr. Atkinson holds that "the burden of proof rests upon those who put forward the idea of 'a fatal fall in prices' to explain how it is that the disaster which they impute to producers has been consistent with the greatest progress

ever made in developing production and commerce in these two great staples."

One of the reasons assigned for the confusion of ideas is "that the elementary principle—that the money itself is not the object of an exchange of goods for money, but, rather, what money will buy—is almost wholly wanting in the public mind and in the every-day discussions of the money question."

A Piece-Rate System.

THE title might at first seem to indicate that this review ought to be relegated to the department of mechanical engineering, but, as the subject is treated as "a step toward a partial solution of the labor problem," by Mr. Fred. W. Taylor, in a paper presented at the June meeting of the American Society of Mechanical Engineers, it seems to have an intimate rela tion with the general trend of current discussion in industrial sociology. The paper describes a system of management introduced by its author in the works of the Midvale Steel Company, of Philadelphia, and which, having been tested for a period of 10 years, is claimed to have been most satisfactory.

In introducing this description, Mr. Taylor alleges that the "ordinary piecework system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this is most serious. Under it even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

"The system introduced by the writer, however, is directly the opposite, both in theory and its results. It makes each workman's interests the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

"The system consists of three principal elements: (1) An elementary rate-fixing department. (2) The differential rate system of piece-work. (3) What the author believes to be the best method of managing men who work by the day.

"Elementary rate-fixing differs from other methods of making piece-work prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed, and, when a piece-work price is wanted for work, the job is first divided into elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data. While this method seems complicated at the first glance, it is, in fact, far simpler and more effective than the old method of recording the time required to do whole jobs of work, and then, after looking over the records of similar jobs, guessing at the time required for any new piece of work.

"The differential rate system of piecework consists briefly in offering two different rates for the same job,—a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be such that the workmen can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piecework, in which the wages of the workmen are reduced when they increase their productivity.

"The system by which the writer proposes managing the men who are on daywork consists in paying men and not positions. Each man's wages, as far as possible, are fixed acc ording to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record.

"The advantages of this system of management are: first, that the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid; second, since the rate-fixing is done from accurate knowledge instead of more or less by guess-work, the motive for holding back on work, or 'soldiering,' and endeavoring to deceive the employers as to the time required to do the work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men; third, since the basis from which piece-work, as well as day-rates, are fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work; fourth, it is for the common interest of both the management and the men to coöperate in every way, so as to turn out each day the maximum quantity and best quality of work; fifth, the system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man, and, when this maximum is once reached, it is automatically maintained by the differential rate; sixth, it automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior; finally, one of the chief advantages derived from the above effects of the system is that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary. There has never been a strike under the differential rate system of piece-work, although it has been in operation for the past 10 years in the steel business, which has been during this period more subject to strikes and labor troubles than almost any other industry.

"In describing the above system of management, the writer has been obliged to refer to other piece-work methods, and to indicate briefly what he believes to be their shortcomings."

This system has seemed so important that we have quoted liberally from the exposition of its general features, as given in the introduction; and we may return to its details in a future review.

Gold Hoards.

THE persistent accumulation of gold in the financial centers of Europe, and the resulting constant increase of bank revenues, is ably commented upon in an editorial in *The Engineering and Mining Journal* (June 8). This accumulation is history repeated; the same thing has occurred in previous panic periods, as the result of abnormal timidity of capital. "The fall in prices of products of all kinds which follows a temporary cessation of demand does not stimulate buying, nor does the cheapness of money at such periods favor investment. The vast majority of men buy goods on a rising, not on a falling, market, and the same rule applies to purchases of securities of all kind. When money must be invested, it is put into property which seems to offer a perfectly safe return, and everything which presents the least risk is neglected. It is this which explains the apparent anomaly of the rise of certain recognized securities—such as British consols, French rentes, United States bonds, and the like—at a time when all other values are falling. The same rule governs in speculative transactions as well as in investments. A speculation for a fall—a "bear" operation—is never popular; nearly all men, including many of those who make speculation their business, prefer to operate for a rise, and it is only a few, who are at once shrewd observers and have the courage to follow their judgment, who are large buyers in panic times, and realize usually enormous profits."

"In addition to the amounts shown in the bank returns, there has been private hoarding of gold on a considerable scale, though it is impossible to estimate with any degree of accuracy its total amount." The increase in public and private stores, however, has been sufficient to absorb the

total additions made to the world's stock of gold for several years past, and to make large drafts upon the stores previously existing.

In our own country any accumulations of this kind have been prevented by special causes, the chief of which has been the withdrawal of foreign capital, the result of distrust aroused by the condition of our currency and a widespread fear that our treasury would be unable to maintain its payments in gold,—a fear largely due to our "cheap money" agitators. Other causes might be named, but this is enough.

But the present hoarding exceeds all precedent. The total gold now held in the specie reserves of the Bank of England, Bank of France, Austro-Hungarian Bank, Netherlands Bank, Bank of Spain, Bank of Italy, and Imperial Bank of Russia is $1,089,603,000. The total silver held in these reserves is $480.400,000,—making a grand total of $1,570,003,000. To this must still be added the reserves of the Imperial Bank of Germany in silver and gold, $272,720,000, and that of the Bank of Spain, $22,037,000 in silver and gold, bringing the grand total up to $1,864,760,000.

"In addition to the bank reserves reported, there are other notable gold hoards in existence in Europe. The German government has carefully guarded at Spandau the so-called 'war treasure' of $30,000,000, which is not to be touched except in an emergency. It is poorly represented in circulation by a special issue of notes, but the gold itself is withdrawn from use. The Austrian and Hungarian treasuries at the present time hold about $90,000,000 in gold, accumulated in preparation for the resumption of specie payments. Finally, the Russian government holds a reserve, the actual amount of which is unknown, but is believed in well-informed quarters to be large enough to bring the total of the three great government hoards up to at least $175,000,000." It is thought that this hoarding will be still further increased, but to what extent cannot be predicted. One reason for such a belief is found in the American clamor for free silver.

English Engineering Supremacy Departing.

WHEN English publications themselves admit that the prestige of English engineering industries among those of other nations can no longer be maintained, and cite such proofs as are quoted below from *Industries and Iron* (March 1), it cannot be deemed invidious for an American periodical to reprint these proofs, although our patriotism is not of that violent, exorbitant, and abounding kind which rejoices in the misfortunes of another land. The events which the above-named newspaper cites as significant of the decadence of British engineering industries are as follows:

"For a contract for several hundred wagons for the Cologne Direction of the Prussian State Railways, a Milan firm tendered a lower price than over twenty German firms. The tender is not likely to be accepted, for reasons of State policy, and the work will probably be undertaken by a German firm. The fact, however, remains that competition is taking a wider and wider area."

"For a quantity of bridge material for Egypt no English tender was even submitted, those received being entirely from French and Belgian establishments. In the Norwegian contract for steel rails a Belgian firm took the major portion out of 9000 tons, only 3000 tons coming to this country. More significant still is the fact that the railway commissioners of our own colony of Victoria have recently given a contract for a number of locomotive crank axles, draw and buffer springs, etc., to the value of about £7000, to Krupp's of Essen."

The same paper expresses the fear that instances of this kind might be multiplied, and admits the inability of English engineers to compete with foreigners in British colonies and in the very department of industry in which the country has hitherto been supposed to be preëminent.

Consul J. C. Monaghan, at Chemnitz, in a recent report to the State department regarding the competition between Germany and England in the machinery mar-

ket, says the Germans are now making a very strong effort to supplant British machinery in foreign countries, particularly in the United States. Mr. Monaghan thinks that despite England's favorable natural advantages, the long time in which she has been selling to this country and the fact that Americans are not inclined to buy much foreign made machinery, there is now and will be for some time a fair market here for certain classes of imported machinery. Among these are rotating presses, protected by patents, for fine illustration purposes, special machines for making beet sugar, cement and safety matches, and also machines in which, because of limited demand in the United States and a limited supply of labor familiar with the construction of such machines, American manufacturers have as yet done nothing. In spite of the import duty, machines may be exported from Europe to the United States at a profit, provided that prices are low enough, delivery is made on time and absolute certainty is guaranteed that, in case of breakage, parts of machines will be supplied from store in the United States.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*32399. The Signs of the Times.—A Forecast of Industrial Activity. Edward Atkinson (Eng Mag-Aug.) 5500 w.

*32407. Business Opportunities in Colombia.—Their Great Number and Variety. Ill. C. F. Caracristi (Eng Mag-Aug.) 3000 w.

32428. Gold Hoards. Editorial (Eng & Min Jour-June 8.) 1400 w.

*32455. The Bimetallic Argument. Herman Schmidt (*Bank Mag*-June.) 3000 w.

*32456. Some Monometallist Arguments. Hartley Withers (*Bank Mag*-June.) 2800 w.

†32462. Monopolism in the City of Churches.—A Review of the Brooklyn Street Railway Strike. G. Emil Richter (Arena-June.) 9500 w.

†32490. The Precious Metals.—Appreciation or Depreciation? Edward Atkinson (Bank Mag-June.) 4400 w.

†32491. Bimetallism. I. As a Bubble. Henry Dunning McLeod. II. As a "New Way to Pay Old Debts." J. W. Cross (Nineteenth Cent-June.) 7500 w.

32508. Trust and Trade Monopolies. W. Clyde Jones (Elec Engng-June.) 3500 w.

*32585. The Shipping Federation.—Why It Was Formed, and What It Has Done (*Fairplay*-June 7.) 4300 w.

†32617. A Piece-Rate System.—A Step Toward Partial Solution of the Labor Problem. Fred W. Taylor (Am Soc Mech Eng-June.) 9000 w.

†32821. How Free Silver Would Affect Us. Edward O. Leech (N Amer Rev-July.) 2200 w.

†32823. "Coin's Financial School" and Its Censors. W. H. Harvey (N Amer Rev-July.) 3800 w.

*32824. The Industrial Problem of the Pacific Coast. I. C. E. Grunsky. II. George W. Dickie (Jour As Eng Soc-May.) 5000 w.

32830.—$1. The Ethical Basis of Distribution and Its Application to Taxation. T. N. Carver (An Am Acad-July.) 6500 w.

32831.—$1. The "Minimum" Principle in the Tariff of 1828 and Its Recent Revival. S. B. Harding (An Am Acad-July.) 5200 w.

32835. Corporations and the Tyranny of Labor. Editorial on Address of Henry B. Brown (Arch & Build-June 29.) 1200 w.

*32864. Tariff Changes and Customs Regulations. Great Britain and Uruguay. Russia. Norway. Sweden. Germany. France. Belgium. Portugal. Spain. United States. Peru. Mexico. Colombia. British Honduras. Tahiti. China. Persia (*Bd of Tr Jour*-June.) 6500 w.

*32865. "Coin's" Food for the Gullible. J. Lawrence Laughlin (Forum-July.) 4500 w.

*32866. Wall Street and the Credit of the Government. I. Period of Declining Credit. II. The Turn in Affairs. III. Personnel of Some of the Leaders in the Silver and Anti-Silver Fight of 1894-5. IV. The Syndicate. V. The Contract. VI. The Loss of Credit and Its Causes. Ill. Albert C. Stevens (Rev of Rev-July.) 7500 w.

*32964. Demand and Supply. Anon. (Ind'y-July.) 1200 w.

32968. Responsibility of the Public in Railroad Strikes. C. M. Hobbs (Ry Rev-June 29.) 2000 w.

*33004. Lincoln on a Government Bank (Soc Ec-July.) 3800 w.

*33005. Integrity of Economic Literature (Soc Ec-July.) 5000 w.

*33006. Protection and Bimetallism (Soc Ec-July.) 1800 w.

*33007. The War and Labor in Japan (Soc Ec-July.) 1100 w.

*33008. The First Trade-Union Incorporated. Charles Cowley (Soc Ec-July.) 900 w.

33009. Export Trade and How to Secure It. C. D. Mitchell (Tradesman-July 1.) 2000 w.

*33016. A Plea for the Gold Standard. W. R. Harper (Am Mag of Civ-July.) 6200 w.

*33075. The Settlement of Labor Disputes by Conciliation and Arbitration. J. Stephen Jeans (*Ir & Coal Tr Rev*-June 28.) 4000 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

The Japanese Marine.

PERHAPS nothing indicates more strongly the tremendous strides which Japan has made in civilization than the growth of her military and mercantile marine. At a recent meeting of the Japan Society (London) Dr. Francis Elgar read a most interesting paper on this subject (*Steamship* for June), of which we make the following abstract:

The Japanese navy consists of thirty-three ships of all classes, and forty-one torpedo boats. These are exclusive of the ten ships recently captured from the Chinese. Four of these ships are wooden sailing vessels used as training ships. The others comprise the armor-clad Fuso; three cruisers, with small belts of armor at the water-line; seven fast steel cruisers of modern construction, protected by deck armor; six steel unprotected cruisers; one torpedo gunboat of modern type; and ten composite or wooden sloops and gun vessels. The armor-clad Fuso and two of the belted cruisers Hiyei and Kongo were built nearly 20 years ago, and have only a maximum speed of 13 knots. The other armored cruiser, Chiyoda, and the seven deck-protected cruisers are, however, among the fastest ships afloat. One, the Yoshino, is perhaps the fastest cruiser at present in the world, as she is said to have obtained the speed of 23 knots with forced draught upon trial. Four of the others are said to have maximum trial speeds of 18¾ and 19 knots, and the remaining three a speed of 16 knots. These ships are armed with the most modern Krupp's, Armstrong's, or Canet's guns, and they carry large numbers of quick-firing guns and machine guns in addition to their main armaments, which were very effective against the Chinese ships in the recent war. This was the state of the Japanese navy before the commencement of the late war. It has, however, now been increased by the addition of ten Chinese ships taken at Wei-hai-Wei,—one at the engagement which took place on the 25th July last off the island of Phung-do, when the Kow-shing was sunk, and one small gunboat captured at Neuchwang since the ice broke up. The ten vessels taken at Wei-hai-Wei are the armor-clads Chen-Yuen and Tsi-Yuen, the coast-defence armor-clad Ping Yuen, the deck-protected cruiser Twang Ting, and six gunboats, known as gunboats of the Alpha-Betta class. These vessels are doubtless more or less damaged, but the armor-clads will certainly be repaired in Japan, and become effective additions to the strength of the Japanese navy. Besides the above vessels, there are three fast cruisers of the most modern type building in Japan, to have a speed of 20 knots, one of which, named the Suma, was recently launched at Yokosuka." Two large battleships are also building in England which will be "much more powerful than any foreign men-of-war in the East, and will rank among the first-class battleships of the world. It will be seen that, when the great battleships building in England, and the three fast cruisers building in Japan, are completed, and when the ships taken from the Chinese have been put into a state of efficiency, the Japanese navy will be one of great power. This power is not likely to diminish. There exists in connection with the Japanese navy all the essential elements of development and progress. It is not a case of acquiring ships, some of which may perish and not be replaced, or which cannot be effectively officered and manned so as to be used to the best advantage. The Japanese government have not merely acquired a large number of ships, but they have also created and developed the means of building ships of the highest class for themselves, and of keeping them in good repair. It is perhaps very imperfectly realized here how much can be and is being done in Japan in modern ship construction.

"The modern mercantile shipping of

Japan is of even more recent growth than the imperial navy, and is not more than 20 years of age. It was the difficulties in the way of despatching an expedition to Formosa in the spring of 1874 that demonstrated to the government of Japan the importance of having a fleet of steamships under their national flag.

"The most remarkable feature of the recent changes in Japanese shipping is its evident permanence, and the elements it contains of rapid development and great future progress. The Japanese have not only obtained a fleet of modern warships, as South American and other non-European governments have done, but they have also acquired with the ships the ideas which are necessary to understand them in all the details of their construction and use, and also how to produce such ships for themselves, and to train officers and men who can use them effectively in action. It is one of the most striking instances in the history of the world of the acquisition and assimilation of knowledge and methods that we would have thought in Europe are altogether foreign to the genius of the people."

Corrosion of Boilers and Steam-Ships.

THE *Steamship* for June has an able article on this subject written by Mr. Wm. C. Ward, and reprinted from *Cassier's Magazine*. From years of patient experiment and observation by Mr. Parker, of the British board of trade, and Mr. Phillips of the Institution of Civil Engineers the following conclusions have been reached. "With steel unprotected and exposed to the action of the weather and sea water, corrosion advances at the rate of 1 in. in depth in 82 years, while under the same conditions for iron the rate is 1 in. in 190 years. When exposed to the weather and fresh water, it is 170 years for steel and 630 years for iron. When always immersed in sea water, the periods are 1 in. in 130 years for steel, and 1 in. in 310 years for iron; and, when always immersed in fresh water, the periods become 600 years for steel and 700 years for iron."

The theories that have been advanced for the more rapid corrosion of steel have been: "(1) Want of homogeneity in the metal; (2) galvanic action between iron and steel, when placed in contact; and (3) galvanic action between the steel and its covering of black oxid. With regard to the first theory, it was stated that local action took place, owing to the unequal diffusion of the manganese. But, with the fact that steel-makers can now produce steel with a practically uniform distribution of the manganese, this theory had to 'go by the board.' The theory that steel is, by means of galvanic action, injuriously affected by iron in contact with it was put forward when steel was in its infancy, and seems to have lasted as long as the blame could be thrown upon the rivets. But, with the introduction of steel rivets and the continuance of the corrosion, this theory was entirely disproved.

"In 1879 Sir Nathaniel Barnaby stated that, when the surface oxid was left on steel plates, its effect on the neighboring bared metal was as strong and continuous as copper would be; and in 1887 Mr. Rayton Dixon gave before the Institute of Naval Architects his experience as to a vessel which had been built some 8 years before, entirely of steel, and which had been greatly corroded. On looking at a portion of the interior plating of the part of the vessel where it had not been coated with paint or anything, you could see the mill scale on it, just as it came from the rolls.

"In 1882 Mr. Farquharson, on behalf of the British admiralty, conducted a number of experiments to test the action of mill scale upon plates. They were exhaustive, and the result was to establish beyond dispute that no pitting occurred in mild steel when freed from mill scale; that the loss of weight from corrosion of clean mild and clean iron did not differ much; and that the action of the mill scale is considerable and continuous, like that of a similar quantity of copper. Since these experiments, the admiralty have never wavered in their practice of causing all their steel plates to be 'pickled' to remove the mill scale, as is done for galvanizing."

Particles of carbon and slag present in metal are fruitful sources of corrosion and

pitting. The pickling process removes such particles from the surface, where they are chiefly to be found. The action of protective or anti-corrosion paints, usually compounds of lead and zinc, is asserted to be "extremely limited." Such paints possess little value over ordinary paints, when applied to plates covered with mill-scale. It is therefore recommended to pickle all plates, and to thoroughly clean and dry them before painting, the mill-scale being a potent factor in setting up corrosion when plates are immersed in sea water.

Corrosion in boilers is more rapid than in hulls of vessels, because in the former the chemical reaction is intensified by heat. External corrosion of boilers is mostly due to leakage. Internal corrosion takes place from chemical, electrical, and mechanical action, which sometimes combine to accelerate the injury. General wasting and pitting are caused by chemical and electrical action. These actions may be induced by the lubricants used in the engine finding its way into the boiler; air or oxygen dissolved in the water; the presence of mill-scale, carbon, or oxid of the metal; difference of temperature of the metals; and want of homogeneity in the metal.

"None but the best mineral oils (pure hydrocarbons), having a high vaporizing point, should be used. Even with mineral oil, after vaporization, a change has taken place. If water be evaporated and condensed, it remains water; but, if oil be evaporated and condensed in the presence of moisture, its nature is changed. True, it retains its greasy nature, but it has become oxidized, and on condensation will appear as a slimy emulsion.

"Bad oils, there is no doubt, have frequently caused pitting, wherever they have settled upon the heated parts; and, to prevent the introduction of oil into the boiler, many engineers have adopted the use of sponge or other feed-water filters to extract or retain the oil from the feed water, while others have discontinued the use of internal lubricants altogether. Many of the Clyde and Tyne firms in Scotland are building engines in which no internal lubrication is used. I have seen triple-expansion engines of 5000 h. p. which have run for years without injury; and, whenever I have had opportunity, I have removed or closed all internal lubricators, and have seen nothing but good effects follow. The oil is evaporated before it reaches the cylinder, and goes into the boiler in a condensed state, without having done any good to the engines. A great deal of trouble is caused by air, either dissolved or free, in the boiler. The troublesome matter is, of course, the oxygen in the air. This, forming oxids, is powerfully aided by the exciting saline constituents of sea water to produce galvanic action, and thus destroy the metal."

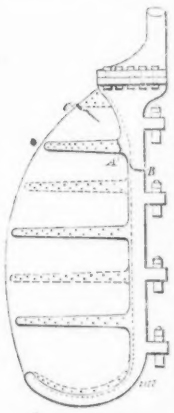
The serious and dangerous pitting observable on sides of furnace tubes results from the same action intensified by heat. Pitting is occasioned by the same causes that induce general corrosion, but these are intensified by two other influences, which render the corrosion local instead of general. The influences are rust, mill scale, or other impurity, and variation of temperature. Rust and iron scale are generally in the form of magnetic oxid of iron; and, when the metal of the boiler is acted on chemically by the sea water while in intimate contact with this oxid, the oxid and the metal in its immediate vicinity constitute a voltaic couple. The metallic iron or steel, being the most readily acted on, become the corroded or positive element. This couple induces a current of electricity, having only a very local influence, thus concentrating the action on that limited portion of the iron or steel which has become positive through the influence of the oxid or scale, instead of allowing that action to spread itself generally over a large area.

The Broken Rudder of the St. Louis.

THE cut illustrating the break in the rudder of this new and splendid steamer is reproduced from *The Engineering Record*. The ship arrived at New York on June 22, completing her first return voyage. The break was discovered when 3 days out from Southampton, and thereafter the vessel was steered by her engines, —an excellent illustration of the wisdom

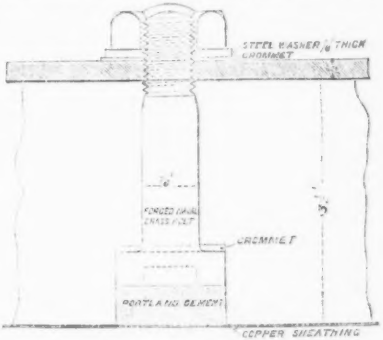
of not relying solely upon the rudder of a large steamship for directing its course. Notwithstanding her mishap, the steamer made the voyage in 7 days and a little over 7 hours.

The cut shows the rudder exactly as it appeared the day after the ship reached New York. "The rudder is made up of an outer frame of forged wrought iron, extending under the keel and having arms extending from it in the after direction, the arms being alternately riveted to the blade of the rudder at opposite sides, as shown by the dotted line. This blade is one sheet of steel, about 1 in. in thickness. At the forward side the blade sets into a groove in the main part of the frame, and the method of attachment between blade and frame is shown by the rivets. On the forward side of the frame are attached the four pintles. The rudder is attached to its head by a flange joint, as shown, there being a tongue and a groove in the longer direction to re-enforce the bolts. Evidently the initial break took place at *A*. The frame is broken entirely through at this point in a long scarfing break; being lowest at this point at the starboard side and extending diagonally upwards and across so as to be nearly 2 ft. 6 in. higher on the port side of the rudder. A piece is also broken out of the scarf, from 12 to 14 in. long, that seems unaccountable in a wrought-iron or steel frame. The break at this point looks like what would take place in a metal of no ductility, like certain grades of brass. The break at *B* undoubtedly next followed, as all the torsion of the blade then came on that arm. A crack has also started across the plate at *C*, which would undoubtedly soon have worked across to the point *B*. The cross-section of the metal at the point *A* was about 12×14 in." The vessel was not delayed in port by the necessity of repairs, as the rudder of her sister-ship, the *St. Paul*, was substituted for the broken one.



Wood and Copper Sheathing for Steel Ships.

IN a paper read at the summer meeting of the thirty-sixth session of the Institution of Naval Architects, June 11 (*The Engineer*, June 14), Sir William White discussed the various methods and materials now in use for sheathing vessels, and described, among others, a system which has been applied to the English battleships Centurion, Barfleur, and Renown, and also to a number of cruisers, and which has so far proved completely successful in preventing galvanic action between the copper and iron or steel hulls.



The cut illustrates the system, in which "a single thickness of wood-planking is fastened to the skin plating with bolts of naval brass screwed through the steel skin, with nuts hove up on iron or steel plate washers and gromets on the inside of the bottom plating. The features of the system are: (1) The adoption of such a thickness of wood sheathing as will admit of thorough caulking. The mean finished thickness of teak accepted is 4-in. for large ships and 3½-in. for the smaller classes. (2) The use of naval brass bolts and nuts, with their points screwed through the skin plating, and with thin plate washers fitted underneath the nuts. (3) The thorough water testing of the skin plating before planking is worked. (4) The most careful fitting, fairing, and fastening of the planks; the coating of all faying surfaces with suit-

able compositions before the planks are fixed in place; and the subsequent injection of composition in order to fill any interstices left between the planking and the plating. (5) The use of hempen gromets steeped in red lead under the bolt heads and under the plate washers, to secure watertightness in the bolt holes.

The Volume of Ships.

AT the recent Paris meeting of the Institution of Naval Architects, Lord Brassey presiding, a paper was read by M. V. Daymard, discussing the utility of making the calculations of the total external volume of ships, and of drawing out the complete scale of solidity, from the triple point of view of tonnage laws, stability, and load line. *Engineering* (June 21), in reporting upon this paper, says that "the author, in view of the confusion that exists from the great divergences in tonnage rules, proposes to solve the problem by considering the whole external volume of ships." The author claims that this unification of tonnage rules, while it would tend to bring about a uniform system, would entail upon no one any heavier dues than are now imposed.

The paper brought out an interesting discussion, the speakers complimenting M. Daymard upon his attempts to solve this difficult problem. It was said that, if it could be done satisfactorily, the author would be entitled to the gratitude of dock companies and ship-owners. All agreed that uniformity of tonnage rules was desirable, but the consensus of opinion appeared to be that the method proposed would not be adopted. In closing the discussion, the author stated that his purpose was more to suggest general principles than to propose a method in the expectation that it would be adopted as a whole.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*32405. Robert Fulton and His Steamboats. —Some Unpublished Historical Facts. Ill. T. C. Purdy (Eng Mag-Aug.) 2500 w.

*32406. James Rumsey, Steamboat Inventor.—The Predecessor of Fulton. Ill. James Weir, Jr. (Eng Mag-Aug.) 2000 w.

*32423. Corrosion of Boilers and Steamships. William C. Ward, in Cassier's Magazine (*Steamship*-June.) 4200 w.

*32424. Dr. Francis Elgar on Japanese Shipping (*Steamship*-June.) 2100 w.

*32425. The Combustion of Fuel. G. F. W. Bapty (*Steamship*-June.) 1800 w.

†32498. Where the Steamboat was Born. Maggie Symington (New Sci Rev-April.) 1700 w.

32523. Electricity on the "St. Louis." Ill. (Elec Wld-June 15.) 2000 w.

32537. Marine Propulsion by Gas-Power. Ill. (Pro Age-June 15.) 1800 w.

32674. Fire Boat for the City of Boston. Ill. (Am Mach-June 20.) 1500 w.

*32709. The New American Trans-Atlantic Steamers. Editorial (*Engng*-June 14.) 1900 w.

*32712. On Wood and Copper Sheathing for Steel Ships. William White (*Eng*-June 14.) 1600 w.

32854. The Broken Rudder of the American Line Steamship "St. Louis." Ill. (Eng Rec-June 29.) 400 w.

*32897. The Port of Auckland. Ill. (*Trans*-June 21.) 1800 w.

32975. The "St. Louis." Ill. (Am Mach-July 4.) 600 w.

*33050. The Cost of Warships (Abstract.) Francis Elgar (*Ind & Ir*-June 23.) 5500 w.

Serials.

21969. The Shark and the Sailor. A. Ewbank (*Ind Engng*-Began April 14, 1894—24 parts to date—45 cts. each).

31117. Traction of Boats on Inland Waterways. W. H. Wheeler (*Eng*-Began April 12—2 parts to date—30 cts. each).

32208. The New British Cruiser "Terrible." Ill. (*Engng*-Began May 24—Ended June 28—4 parts—30 cts each.

32353. Breakdowns at Sea. Ill. W. Welbury (Eng-Began May 31—Ended June 14—2 parts—30 cts. each).

32577. Light-Draught River Steamers. George Rickard (*Ind & Ir*-Began June 7—Ended June 21—2 parts—30 cts. each).

32680. Electricity for Marine Propulsion. W. F. Durand, in Cassier's Magazine. (Elec Rev-Began June 19—Ended June 26—2 parts—15 cts. each).

32880. The Machinery of the American Liner "St. Louis" (Engng-Began June 21—Ended June 28—2 parts—30 cts. each).

32886. Marine Engineering and Shipbuilding on the Thames (*Eng*-Began June 21—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Calorimetric Tests of Steam.

MANY vagaries that have manifested themselves in calorimetric tests of steam in trials of evaporative capacity of steam boilers may probably be accounted for by the peculiar way in which suspended water is distributed in the steam pipes from which the steam is drawn for making the tests. It has long been suspected that some action not understood, taking place in a steam pipe conveying live steam, was one of the causes of the curious results sometimes reached. An important paper on the subject read before the June meeting of the American Society of Mechanical Engineers, by Prof. D. S. Jacobus, refers to late experiments of Prof. Denton, with small throttling calorimeters, results of which indicated "that various calorimeter nozzles, such as are now used in practice, do not give an average sample of the steam flowing through the steam main." The paper deals specifically with a calorimeter nozzle devised by Prof. Denton, which has demonstrated the fact that suspended water in steam flowing through a pipe is very unequally distributed throughout the steam, for the most part flowing near the bottom of a horizontal or inclined pipe, and probably in a small stream nearly parallel with the axis of the pipe.

We have reproduced the drawing accompanying the paper, which illustrates Prof. Denton's apparatus and the action referred to. The nozzle used "consists of a ½-in. pipe, passing through a stuffing-box and so arranged that it may be moved to any position across the pipe under full head of steam."

The tests made with this apparatus indicated that a greater part of the moisture was near the bottom of a horizontal pipe, and that it probably ran along in a small stream. If this was true, then an opening in the bottom of the pipe, so arranged that the water could run freely into it, would glean off all, or the greater part, of the moisture. The tests which are the subjects of this paper were made to determine to what extent such an action takes place, and are a continuation of the preliminary investigation above referred to.

It was found that, after steam had passed through 8 ft. of horizontal 3-in. pipe, 95 per cent. of the entrained moisture, or over, could be drawn from a 1-in. pipe leading from the bottom of the 3-in. pipe, for quantities of moisture as high as 8 per cent., and velocities as high as 25 ft. per second.

The moisture was thoroughly mingled with the steam before entering the 3-in. pipe. The apparatus was so arranged that initially the greater part of the moisture was near the top of the pipe, so that it had to fall through the steam during the time taken to travel over the space of 8 ft. The theoretical time required for a body falling freely in space to travel from the top to the bottom of the pipe is about ⅛ sec. Hence, the maximum initial horizontal velocity that such a body could have and reach the bottom in a horizontal space of 8 ft. would be 64 ft. per second.

It appears from the experiments, therefore, that, for the particular set of conditions which existed, 95 per cent. of the moisture can be gleaned from the bottom of a pipe, if the velocity of the steam is ⅛ that corresponding to the theoretical velocity already mentioned. For a velocity of 20 ft. per second, or about ½ the theoretical velocity, 98 per cent. of the moisture was drawn from the bottom of the pipe for quantities of moisture as high as 10 per cent. For a velocity of 43 ft. per second, or 7-10 of the theoretical velocity, about 60 per cent. of the total moisture was drawn from the bottom of the pipe, and at ½ of the theoretical velocity about 90 per cent. was drawn out. It cannot be said that these ratios will apply to all cases, and for this reason additional tests are to be made to determine the effect of

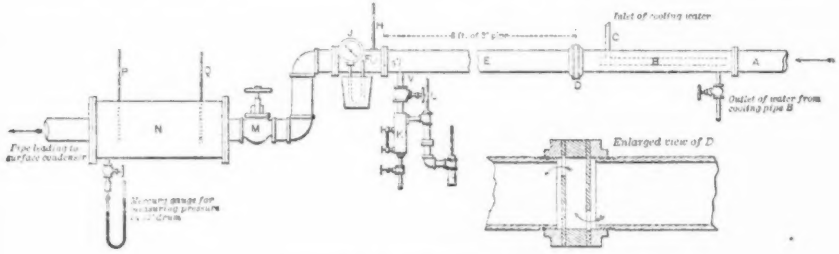
increasing the length of the horizontal pipe.

"In Professor Denton's experiments a single calorimeter was at first attached to the bottom of a horizontal 12-in. pipe by means of a nozzle which could be raised and lowered so as to draw steam from various sections of the pipe, as has been already described. It was found that the weight of moisture ranged between about 5 and 50 per cent. of the weight of steam passing through the calorimeter, when the nozzle was lowered so as to be near the bottom of the pipe; whereas, when the nozzle was raised so as to be about 1¾ in. above the bottom of the pipe, the steam which passed through the calorimeter was practically dry. In these tests the steam passed from the boiler through about 10 ft. of horizontal 12-in. pipe to an elbow, and thence through a second horizontal 12-in. pipe. The calorimeter was attached to the second horizontal pipe about 6 ft. from the elbow. The velocity of the steam was about 17 ft. per second, representing about 500 h. p.

"After making the tests with a single calorimeter, a second series of tests was made with two calorimeters, to determine if the moisture was all at the bottom, or if it was also creeping along the sides of the pipe. To make these tests, the second calorimeter was placed at the same cross-section of the pipe as the first, but it was moved to one side, so as to be 4 in. from the calorimeter attached directly to the bottom of the pipe. It was found that, when both nozzles were set so that the ends were flush with the inner surface of the pipe, the calorimeter at the bottom of the pipe indicated successive moisture, whereas the calorimeter 4 in. from it toward the side of the pipe showed practically dry steam. This indicated that all the moisture was at the bottom of the pipe."

The general arrangement of apparatus for conducting the tests on the 3-in. horizontal pipe is represented in the engraving.

"Superheated steam entered at *A*, and passed through a 3-in. pipe surrounding a cooling pipe, *B*. The cooling water entered at *C* and passed off at *G*. After passing the cooling pipe, the steam passed through a device at *D* which thoroughly mixed the steam with the water. This consisted of two plates placed about 1 in. apart, in which were two holes about ⅞ in. in diameter. The hole in the first plate encountered by the steam was at the bottom of the pipe, so that all moisture in the steam would be drawn from the bottom of the pipe. The steam and moisture then passed upward between the plates and out of the hole in the second plate. The hole in the second plate was placed near the top, so as to introduce the steam and moisture near the top of the 3-in. pipe, *E*. The calorimeter was attached at *V*. *K* is the separator portion of the calorimeter, and *L* the heat gage. The temperature and pressure of the steam were measured on leaving the pipe, *E*, by means of the thermometer, *H*, and the pressure gage, *J*. The thermometer, *H*, was placed in a mercury well having an enlargement at its lower end and a thin neck. The steam was throttled by means of the valve, *M*, from a pressure of about 80 lbs. above the



DENTON'S CALORIMETER NOZZLE.

atmosphere in the pipe, *E*, to about the pressure of the atmosphere in the 12-in. drum, *N*. The temperature of the steam after throttling was measured by a thermometer, *Q*, placed in a mercury well, and by a thermometer, *P*, which came in direct contact with the steam. The pressure in the drum, *N*, was measured by means of a mercury gage. The steam flowing into the drum, *N*, was led to a surface condenser, and finally weighed.

"The amount of moisture passing through the valve, *M*, was indicated by the amount of superheating in the 12-inch drum, *N*. This moisture, added to the moisture in the steam entering the Barrus calorimeter, gave the total moisture contained in the steam passing through the 3-in. pipe. Corrections, determined directly by experiment, were made for all radiation. The factor of 0.48, for the specific heat of steam, was employed in calculating the percentage of moisture, and special experiments were made to show how nearly this method would agree, in the case of the 12-in. drum, with the experimental normal reading for dry steam. These experiments, from the nature of the apparatus, could be made only with the steam just at the point of superheating, or with slightly superheated steam, and the results obtained were the same as in similar tests made on a Barrus calorimeter, and given in a paper on 'Errors of Calorimeters,' read at the same meeting.

"Three series of these tests were made. In the first there was no mixing device placed at *D*. In these it was found that the thermometer, *H*, would indicate superheating with considerable moisture entering the calorimeter nozzle, *V*. The second series of tests were made after adding the mixing device, *D*. In the third series of tests the 3-in. pipe containing the cooling pipe, *B*, was lowered, together with the mixing device, *D*, and the steam was made to pass through an S-shaped connection of 3-in. pipe into the pipe, *E*. This caused the steam which was admitted to *E* to pass upward through a vertical pipe, then turn through an elbow into the pipe, *E*. The object of the latter arrangement was to make the mixture of steam and water enter the pipe *E* at the same velocity at which it flowed through it. When the steam and moisture entered the 3-in. pipe directly from a 7-in. hole in the mixing device, *D*, it was initially at a much greater velocity than the average velocity in the pipe, *E*; but it was considered best to make tests in this way, so as to have one set of tests in which the conditions were as severe as possible."

In an appendix a tabulated statement of the results of tests is given.

Carrying Capacity of Gas-Pipes.

WE have not before seen this subject presented in so available and convenient a form as in the following excerpt from a pamphlet published by The Norwalk Iron Works Co. and entitled "A Few Facts Concerning Machines for Pumping Natural Gas," which says:

"It is a common idea that the carrying-capacity of a pipe is in proportion to its internal area. This is, however, not correct. A pipe 4 ft. in diameter has only four times the area of a pipe 2 ft. in diameter, and yet the 4-ft. pipe will carry 5.66 times as much fluid as the 2-ft. pipe, under the same conditions of length and head. In other words, a 2-ft. pipe will carry 17.6 per cent. or nearly 18 per cent. as much as will a 4-ft. pipe. This proportion of carrying-capacity does not hold good for smaller pipes of the same proportionate diameter. A 1-ft. pipe has only 16.6 per cent. of the carrying-capacity of a pipe 2 ft. in diameter, and a 1 in. pipe will carry only 14 per cent. as much as a 2-in. pipe.

"These features have not to our knowledge been heretofore taken into consideration in tables prepared for equalizing pipes. The proper values are given in the table below. In this table the commercial or nominal size is given, but in our calculations we figure 1¼-in. pipe as 1.3 in. diameter, and 1½-in. pipe at 1.6 in., as these are nearer the actual sizes.

"The size of pipe is given in the horizontal line on top, and directly beneath is stated successively the proportion of its capacity that other pipes will carry. These

other pipes are stated in the vertical column on the left.

"For example, a 6-in. pipe can have 15 per cent. of its capacity carried by a 3-in. pipe, 23 per cent. by a 3½-in. pipe, 34 per cent. by a 4-in. pipe, and a 24-in. pipe will carry 38 times as much as the 6-in. pipe.

"In taking branches from a main it is advisable that the sum of the percentages of the carrying-capacities of the branches should be 100 per cent. or more. Referring again to a 6-in. main, we see that, if it be divided into two branches, one 4 in. and the other 5 in., the carrying-capacities of the branches would be respectively 34 and 63 per cent. of the 6-in. pipe. Thus provision is made for only 97 per cent., and there would be slight additional friction from the point of diversion of the branches. If the branches be made 4½ and 5 in., the percentages are respectively 47 and 63, their sum 110, and, from the junction, the flow would be considerably more free than in the first case."

Relative Carrying Capacity of Pipes for Gas.

	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	10	12	24
1	1.	.48	.37	.14	.07	.05										
1¼	2.1	1.	.55	.29	.16	.10	.06									
1½	2.7	1.8	1.	.53	.29	.18	.11	.08								
2	7.14	3.4	1.9	1.	.56	.33	.21	.14	.10							
2½	13.4	6.3	3.5	1.9	1.	.63	.40	.27	.20	.15						
3	21.4	10.3	5.7	3.	1.6	1.	.67	.43	.32	.23	.15					
3½		16.1	9.	4.7	2.5	1.5	1.	.68	.50	.38	.23	.15				
4			13.1	6.9	3.7	2.3	1.4	1.	.71	.56	.34	.23	.15			
4½				9.6	5.	3.1	2.	1.4	1.	.77	.47	.31	.21	.12		
5					6.7	4.1	2.7	1.8	1.3	1.	.63	.42	.28	.16	.10	
6						6.5	4.3	2.9	2.1	1.6	1.	.66	.45	.26	.16	.03
7							6.5	4.4	3.2	2.4	1.5	1.	.71	.40	.24	.04
8								6.3	4.7	3.5	2.2	1.4	1.	.59	.38	.06
10									8.3	6.3	3.9	2.5	1.7	1.	.61	.10
12										10.5	6.5	4.1	2.8	1.6	1.	.17
24											38.	24.	17.3	9.6	6.	1.

Reporting Boiler Tests.

A CRITICISM of the standard code of reporting boiler trials, heretofore employed by the American Society of Mechanical Engineers, was read at the June meeting of the society by F. W. Dean. The question of reporting a boiler trial in such a manner as to show its true value "as a generator of the possible heat in the fuel and as an absorber of the heat generated independent of the quality of the fuel" is dealt with, and the attempt is made to show that the code of the society, if followed, does not, at least in some cases, insure that these determinations will be clearly indicated. The efficiency must be determined and reported. The term efficiency is defined as "the ratio between the heat which any given coal can generate by complete combustion, and that part of it which is absorbed by the water and steam heated and generated." Through the efforts of the society, Mr. Dean hopes to make the public understand the meaning of efficiency.

"This naturally leads to a discussion of the report by a committee of and to this society, recommending a standard method of making and reporting boiler trials, as printed in Volume VI of the 'Transactions.' That report is emphatic in expressing the desirability of a standard method, and particularly of the importance of expressing the value of the boiler. On page 259 the report says: 'The scheme must also be so complete that, if carefully and exactly followed, the precise value of the boiler may be ascertained with certainty.' Yet after this the word 'efficiency' is scarcely mentioned, much less recommended as a measure of value, thus wholly missing the point. Wherever used, it is in the most general sense. In one discussion it appears with its proper signification.

"The report recommends, on pages 262–3, that its standards of power and economy be respectively the 'commercial horsepower' and 'unit of evaporation,' both of which are explained. It then says (page 263) that the relative economy of boilers is expressed by the number of units of evaporation obtained by a pound of combustible. Nothing could be further from the truth. In fact, this conveys only the roughest idea of the relative economy of boilers, and takes no account of the fact that combustible, as well as coal, varies in heat value per pound. In a recent case that came under the writer's notice a pound of combustible contained 14,177 units of heat, and another 15,398. The latter is 8.6 per cent. greater than the former, and therefore ought to evaporate at least 8.6 per cent. more water from and at 212.° If the evaporation per pound of combustible in the two boilers using these coals had been equal, according to our society's code, they would have been

equally good boilers. It is evident, however, that they would have been far from equally good. In one case the evaporation was 11.85 lbs., on this basis, while with the better coal in the same boiler it would have been 11.85 + 1.086 = 12.87, thus changing it from a fairly good to be a remarkably good boiler.

"The boiler using the better coal gave a better result than it is in general entitled to, and has apparently misled both its designer and builder, as well as the public, while, if its merits had been judged by its efficiency, it would have taken its proper place as a steam generator."

The comparison of boilers should be made and guarantees should be based on relative efficiency. To this end Mr. Dean submitted to the consideration of the society a new form of blank, which, if adopted, will, he thinks, secure the end sought. Evidently this blank has been carefully thought out. It is too voluminous to be reprinted here. In the discussion following the reading Mr. Geo. H. Barrus, without committing himself or others to the form of blank submitted by Mr. Dean, admitted that the form adopted by the society was behind the times, and that a revision was needed.

Aluminum Alloys.

As alloys of aluminum are finding increasing use in mechanical construction, every contribution to existing knowledge of the subject is welcome. The principal object of an investigation carried out by Messrs. S. R. Leonard and J. H. Schnepel, an account of which is given in *The Sibley Journal of Engineering* for June, was to determine the value of alloys of this metal with tin. "In addition, considerable work was done with the pure metal, and with some scattering alloys other than those of tin, in the form of bars taken from cold rolled sheets. This mechanical treatment of the metal is of great importance,—more, comparatively, than the alloying with other metals,—while the combination of judicious alloying with effective treatment in the rolls gives remarkable results.

"The material, as received from the Pittsburgh Reduction Co., comprised bar and tension piece castings, and bars sawed from the rolled sheets, of the following grades: 99 per cent. pure aluminum, castings and rolled bars; pure aluminum alloyed with 7 per cent. copper, castings; with 20 per cent. zinc, 3 per cent. copper, 1.3 per cent. manganese, castings; with 2 per cent. and 4 per cent. copper, rolled; with 2 per cent. copper and 1½ per cent. chromium, rolled. Besides these specimens, cast tension pieces were made, containing 2 per cent., 4 per cent., 6 per cent., 8 per cent., and 10 per cent. chemically pure tin."

"The hardness of each alloy was determined. This property is entirely relative, yet may be expressed much more accurately than by the usual method of stating that one specimen will scratch another. In this work the scheme in use for government tests at the Watertown Arsenal was followed. A standard tool was used, and was forced into the metal by a certain load, the reciprocal of the volume displaced being assumed a relative measure of the hardness of the metal. The tool consists of a quadrangular pyramid, with the sides and opposite angles of the base equal, the longest diagonal of which base is 1", the shortest 0.2", the height of the pyramid being 0.1". The indentation made is diamond-shaped, with, of course, a maximum length of 1", width of 0.2", and depth of 0.1"; and the volume displaced is proportional to the cube of the long diameter, the varying lengths of which are easily measured. Al the data in hardness were taken under a load of 4400 lbs., that being used for similar work at Watertown."

The table herewith gives results obtained from a variety of alloys. Alloys with tin appear to be uniformly weaker than the unalloyed aluminum. Another notable peculiarity is that "the alloys seem to have uniformly greater fibre-strength in the transverse tests.

"All of the cast specimens, whether tin or other alloys, have very poorly defined elastic limits, the stress-strain diagrams departing from the straight line of perfect elasticity from the very beginning. The rolled specimens show a characteristic change in this respect. Within a fairly defi-

nite elastic limit their stress-strain diagrams are perfectly straight lines.

"Two of the scattering alloys are of especial interest. One containing 20 per cent. zinc, 3 per cent. copper, and 1.3 per cent. manganese has the greatest ultimate strength of all, but is very hard and brittle. Alloys like this, containing considerable zinc, are especially used to give hardness to other grades with which they are mixed. The specimens containing 2 per cent. copper and 1½ per cent. chromium stand second in strength in the list, showing the marked effect of a very little chromium in hardening and strengthening the metal."

	Character of Group of Specimens.	Strength. Lbs. Per Sq. In.				Modulus of Elasticity. Lbs Per Sq. In.		Ductility, Per Cent In Tension.	Relative Hardness.	Specific Gravity.
		Tension.		Transverse.						
		Elastic	Maximum.	Elastic	Maximum.	Tension.	Transverse.			
Cast.	Aluminum, 99 per cent., pure	4000	12250	2345		8,385,000	8,440,000	5.62	3.61	2.662
	7 per cent. copper	6250	18550	9000	25250	11,115,000	8,065,000	1.00	12.87	2.820
	20 per cent. zinc, 3 per cent. copper, 1.3 per cent. manganese		35070		23420	9,685,000	8,060,000	15	35.56	3.081
Rolled.	Aluminum, 99 per cent. pure	12500	17180	18310		9,780,000	10,055,000	8.49	7.03	2.712
	2 per cent. copper	9000	18850	16290		9,505,000	9,965,000	19.43	9.54	2.741
	4 per cent. copper	16020	23050	26590		10,440,000	10,330,000	3.62	12.88	2.774
	2 per cent. copper, 1½ per cent. chromium	19000	26310	26310		9,850,000	9,813,000	1.31	14.09	2.759
Cast.	2 per cent. tin	2150	8622			5,435,000		4.00	3.71	2.689
	4 per cent. tin	2400	9505			6,210,000		5.38	3.74	2.738
	6 per cent. tin	2250	9315			5,035,000		5.19	3.49	2.771
	8 per cent. tin	2000	7270			5,175,000		3.06	3.33	2.803
	10 per cent. tin	1750	7352			6,675,000		3.87	3.09	2.856
	Small iron castings								90.9	
	Wrought iron, 1"×¼"								36.4	

Economy in Steam Engineering.

On this subject Mr. George West in *The Stationary Engineer*, makes some timely remarks anent the sweeping assertions of hustling salesmen of machinery of all sorts, steam engines included. He asks what avail is it to incur the expense of replacing a serviceable engine of suitable capacity by one of the latest improved type, which is guaranteed to work on a consumption of a fair percentage less of steam per horse power, if it be no more suited to the situation than the other? A point in this connection which is not clearly explained at the time is that the engine must be worked at a certain load in order to obtain these guaranteed results. Any deviation from this, above or below the rated capacity, will make a difference in the amount of steam required per horse power developed; and unless we can keep it loaded to this point our new engine will give little if any better results than the one which was replaced did when working at its best.

Sometimes a high-class steam engine which has been proven, by the use of the indicator, to require but a small amount of steam for the development of a horse-power, does not prove as economical as expected, and the reason is sometimes difficult to determine. Unsuitable load may be one reason for the lack of efficiency, and another will probably be found in the long line of bare steam-pipe that connects it with the boiler. Some carefully made tests have shown that where the engine is being worked at its rated capacity a loss of energy by radiation of heat and loss of steam by condensation in the pipes and cylinders has amounted to fully forty per cent, of the total amount of water evaporated in the boiler. Many other losses are possible.

In view of these facts does it seem advisable, or business like, to place such machines in charge of persons who do not understand the principles under which they are built, or the details of their construction, simply because it is found that there is a reduction in the one item of wages while at the same time there is an increase in several items of expense.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

32612. Practical Blacksmithing and Tempering. Ill. Isaac Cowen (Sci Mach-June 15.) 1200 w.

†32621. Force Required and Work Performed in Driving and Pulling Cut and Wire Nails. R. C. Carpenter (Am Soc Mech Eng-June.) 600 w.

32672. Cutting Bevel Gears in a Universal Milling Machine. Ill. Jarus (Am Mach-June 20.) 2800 w.

32676. Spacing Holes, etc. James F. Hobart (Am Mach-June 20.) 1200 w.

*32893. Teeth of Machine Saws. Ill. W. Samuel Worssam (*Ind & Ir*-June 21.) 5500 w.

32970. Redrawing of Wrought Iron Tubes. Ill. (Sci Am-July 6.) 800 w.

32972. The Annealing of Armor Plates by Electricity. W. W. Hanscom (Sci Am-July 6.) 1000 w.

32976. Mechanical Calculating Instruments. William Cox (Am Mach-July 4.) 1000 w.

32981. Unnecessary Work. C. R. Tompkins (Age of St-June 29.) 1100 w.

33011. A Modern Machine Shop. J. B. Rich (Tradesman-July 1.) 2000 w.

Steam Engineering.

32435. Burning Small Coal.—A Description of a Traveling Grate for This Purpose. From a paper by Eckley B. Coxe (Bos Jour Com-June 8.) 1100 w.

32477. Longitudinal Expansion of Steam Mains (Ir Age-June 13) 1800 w.

*32543. The Heat Cycle in the Cylinder Walls. Albert Barnes and H. Zimmerman (Sib Jour Eng-June.) 1500 w.

*32544. Constants for High Speed Engine Design. F. F. Gaines and H. E. Williams (Sib Jour Eng-June.) 1000 w.

*32546. The Heating Values of Coal. E. M. Gilbert and B. P. Flory (Sib Jour Eng-June.) 900 w.

*32547. The Heat Insulating Properties of Different Steam Pipe Coverings. F. J. Emery and J. H. Godfrey (Sib Jour Eng-June.) 1100 w.

*32550. Steam Calorimetry. G. W. Collins and T. T. Hubbard (Sib Jour Eng-June.) 1600 w.

32578. Single-Acting Engines.—Some Points Concerning Their Success in Europe (Bos Jour Com-June 15.) 1100 w.

†32622. The Efficiency of Boilers. A Criticism of the Society's Standard Code of Reporting Boiler Trials. F. W. Dean (Am Soc Mech Eng-June.) 2000 w.

†32624. Tests Made on the Experimental Engine of Sibley College, Cornell University. Ill. R. C. Carpenter (Am Soc Mech Eng-June.) 2500 w.

†32627. The Down-Draught Furnace for Steam Boilers. Ill. William H. Bryan (Am Soc Mech Eng-June.) 5000 w.

†32630. A Method of Proportioning Cylinders for Compound Engines. E. C. Knapp (Am Soc Mech Eng-June.) 1200 w.

†32633. Pipe Covering Tests. Ill. George M. Brill (Am Soc Mech Eng-June.) 3000 w.

†32636. Tests to Show the Distribution of Moisture in Steam When Flowing Through a Horizontal Pipe. D. S. Jacobus (Am Soc Mech Eng-June.) 1800 w.

32761. Water Tube Boilers. Allan Sterling, with Discussion (Can Min Rev-June.) 4700 w.

32813. Something About Steam Gauges. W. H. Wakeman (Safety Valve-June 15.) 1500 w.

32820. The Prevention of Boiler Explosions. Editorial (Eng News-June 27.) 3000 w.

32940. Setting the Valves of a Corliss Engine. Ill. W. H. Wakeman (Mach-July.) 2200 w.

32945. About Chimneys—Some Considerations Necessary to Success (Bos Jour Com-June 29.) 1200 w.

†32955. The Cost of Steam Power. Charles E. Emery (St Ry Jour-July.) 6000 w.

*33058. Draught E. G. Constantine (*Prac Eng*-June 28.) 1500 w.

Miscellany.

*32403. Is the Inventive Faculty a Myth? A Few Posers for Juries and Mechanics. William H. Smyth (Eng Mag-Aug.) 4000 w.

*32419. Metal Spinning. Ill. Anon. (*Ill Car & Build*-May 31.) 1300 w.

32431. A New Channeling Machine. Ill. (Eng & Min Jour-June 8.) 800 w.

32454. Men and Machinery. J. H. Allen, in Dixie (R'y Rev-June 8.) 2000 w.

32484. Paper Punching. Ill. Oberlin Smith (Am Mach-June 13.) 1700 w.

32485. The Adiabatic for Perfect Gases. G. A. Goodenough (Am Mach-June 13.) 500 w.

32486. Mechanics of Safe Burglary. Ill. H. F. G. (Am Mach-June 13.) 1700 w.

32487. Laying Out Angular Work. Ill. Frank Piers (Am Mach-June 13.) 800 w.

32488. The Evolution of a Crank Disk and Shaft. Ill. H. Hansen (Am Mach-June 13.) 1700 w.

*32545. Investigation of Aluminum Alloys. S. R. Leonard and J. H. Schnepel (Sib Jour Eng-June.) 700 w.

†32620. The T-Square and Its Mountings. Ill. W. A. Gabriel (Am Soc Mech Eng-June.) 500 w.

We supply copies of these articles. See introductory.

†32623. The Effect of Length of Specimen on the Percentage of Ductility. R. C. Carpenter (Am Soc Mech Eng-June.) 1000 w.

†32626. New Forms of Friction Brakes. Ill. W. F. M. Goss (Am Soc Mech Eng-June.) 2500 w.

†32628. A New Shaft Governor. Ill. E. J. Armstrong (Am Soc Mech Eng-June.) 500 w.

†32629. A Horse-Power Planimeter. Ill. Edward J. Willis (Am Soc Mech Eng-June.) 500 w.

†32632. Description of a New Form of Sterilizer. A. M. Goodale (Am Soc Mech Eng-June.) 700 w.

†32634. A New Coal Calorimeter. Ill. R. C. Carpenter (Am Soc Mech Eng-June.) 4500 w.

32669 History of Automobile Carriages. Ill. From La Nature (Sci Am-June 22.) 900 w.

32763. Progress in the Cotton Field. Ill. Willard P. Parsons (Mfr & Builder-Jan.) 2600 w.

32804. Napoleon Bonaparte in Egypt, and the Differential Refractometer at the Stevens Institute of Technology. Henry Morton (Sci Am-June 29.) 900 w.

32805. The Faults of the Plow. From La. Planter (Sci Am-June 29.) 1500 w.

32810. The Old and the New. Robert Allison, with Discussion. Presented at Meeting of Am. Soc. of Mech. Eng. (Am Mach-June 27.) 5000 w.

*32879. Road Locomotion. Editorial (*Engng*-June 21.) 1400 w.

*32883. A Great Boiler Explosion. Ill. (*Eng*-June 21.) 1700 w.

*32929. Experiments on the Lubrication of Axle Bearings. E. Chabal (*Prac Eng*-June 21.) 1000 w.

32934. A Reminiscence of the Milling Machine. A. H. Brainard (Mach-July) 1000 w.

32935. Instruments of Precision for the Draughting Room. William Cox (Mach-July.) 600 w.

32938. Strength of Boiler Seams. N. J. Smith (Mach-July.) 1200 w.

32939. About the Inertia Governor. John E. Sweet (Mach-July.) 900 w.

*32967. Some Tests with Fuel Gas, Conducted by the Southern Pacific Company at Sacramento, Cal. Ill. A. J. Treat (Am Eng & RR Jour-July.) 2800 w.

32977. Centrifugal Force. J. Begtrup (Am Mach-July 4.) 1500 w.

32980. Rifling Machines—Theory of Rifling. Payson Burleigh (Age of St-June 29.) 1800 w.

*33079. Production Up to the Power Limit. —The Destructive Use of Machine Tools. H. L. Arnold (Eng Mag-Aug.) 3000 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wld*-Began May 12, 1893—19 parts to date—30 cts. each).

13534. The Gas Engine. (*Mech Wld*-Began June 2, 1893—16 parts to date—30 cts. each).

16781. Rope Driving. Ill. J. J. Flather (Elec Wld-Began Oct 26, 1893—21 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (*Elect'n*-Began Dec. 1, 1893—36 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—20 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Schefiler, Jr. (Mach-Began Oct., 1894—10 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (*Mech Wld*-Began Dec. 7, 1894—10 parts to date—30 cts. each).

30216. Care and Maintenance of Machinery. Ill. (Tradesman-Began March 15—7 parts to date—15 cts. each).

30555. The Proportions and Movement of Slide Valves. Ill. W. D. Wansbrough (*Mech Wld*-Began March 22—6 parts to date—30 cts. each).

31305. Boiler-Making. C. E. Fourness (Loc Engng-Began May—3 parts to date—30 cts. each).

31763. Thermo-Dynamics. W. C. Popplewell (*Prac Eng*-Began May 3—5 parts to date—30 cts. each).

32328. Some Thoughts on Machine Design. Ill. De Volson Wood (Am Mach-Began June 6—2 parts to date—15 cts. each).

32390. Modern Economy in Steam Engines. Ill. W. Arnold (*Prac Eng*-Began May 31—Ended June 14—3 parts—30 cts. each).

32434. Reactive Effects of Our Patent System. Otis Kendall Stuart (Eng-Began June 8—2 parts to date—15 cts. each).

32466. Lubricants and Lubrication. From the Textile Recorder (*Prac Eng*-Began June 7—4 parts to date—30 cts. each).

32675. Facts for Young Engineers. W. H. Wakeman (Am Mach-Began June 20—2 parts to date—15 cts. each).

32677. A Modern Machine Shop. Ill. Horace L. Arnold (Am Mach-Began June 20—2 parts to date—15 cts. each.)

32739. Radial Valve Gearing. Ill. H. J. Teiper (Eng-Began June 22—1 part to date—15 cts).

32814. Description and Trials of Todd's Terminal Exhaust Steam Engine (Safety Valve-Began June 15—1 part to date—15 cts).

32923. Core Grids. Ill. Joseph Horner (*Mech Wld*-Began June 21—1 part to date—30 cts).

33012. Five Years Apprenticeship in the Machine Shop. Anon. (Tradesman-Began July 1—1 part to date—15 cts).

We supply copies of these articles. See introductory.

MINING & METALLURGY

Explosives for Use in Coal Mines.

AT a recent meeting of the Federated Institution of Mining Engineers in London, Mr. Vivian B. Lewes read a paper on mining explosives, the substance of which is given in the *Colliery Guardian* (June 7). The paper is really a monograph of high importance, and in it the author treats his subject especially from the chemical point of view. In reviewing the properties of the various mining explosives now in use, the author, for convenience, classifies them as follows, according to the way in which they produce the gas which gives the explosive effect: (1) Explosion due to simple combustion, as in the case of blasting gunpowder; (2) explosion due to detonation of the whole of the explosive, as in nitroglycerine, nitrocotton, and some Sprengel explosives; (3) explosion due to detonation of part of the explosive, and combustion of the remainder, as in carbonite, westphalite, etc.

As to the first class, gunpowder itself is practically never used, and Mr. Lewes says that "the only word that can be said in favor of the blasting powder is that it is cheap." To this it should be added that in mines other than coal mines, where there is no danger of ignition of inflammable gas or dust, and where a slow, pushing force is needed rather than a sharp, shattering one, the common black blasting powder still holds its own, partly because of its effectiveness and partly because of its cheapness, notwithstanding the danger from premature explosions. But, as Mr. Lewes remarks, it is absolutely unfitted for use in coal mines, and "its abolition would do away with more than three-quarters of the number of deaths caused by explosives." Perhaps it would be better to substitute "a large proportion" in place of the "more than three-quarters" of the text. The great danger consists in the combustible nature of the products evolved during decomposition,—a factor in coal mine explosions which the author thinks cannot be overrated. "On firing a charge of 1½ lbs. of blasting powder, over 3 cu. ft. of combustible gas, chiefly carbon monoxid, would be produced, and this, when mixed with pure air, would give over 10 ft. of an explosive, or, at any rate, rapidly burning mixture; and experiments upon the effects of fire-damp and dust combined show conclusively that, even when fire-damp is present in such minute quantities as to form a mixture very far removed from the point of explosion, it makes the mixture of coal dust and air highly explosive; and traces of carbon monoxid will do exactly the same thing when the air is laden with coal dust." A table is given showing that black blasting powder, taking all the gases as 100, evolves 38.75 per cent. of carbon monoxid, 7.10 per cent. of sulphuretted hydrogen, 2.75 per cent. of marsh gas, and 5.24 per cent. of hydrogen,—all of which mean much flame and consequent danger.

The distinctive characteristic of the explosives of Mr. Lewes's second division is that all the members of it are capable of complete detonation, provided always that the right sort of detonator is used. Nitroglycerine, for example, produces only carbon dioxid, water, nitric oxid and nitrogen,—and no combustible products. It would be the best of all explosives, were it not for the danger inseparable from its physical conditions and sensitiveness to shock. It is, therefore, almost always used with an absorbent (as in dynamite) or in combination (as in blasting gelatine). But "some of the best of the nitroglycerine class, such as blasting gelatine, are among the worst offenders as regards the evolution of combustible products, as the deficiency in oxygen of the nitrocotton is not made up by the excess in the nitroglycerine used." Nitrocotton alone is often used for blasting, but gives a maximum amount of combustible products. Several explosives have been made on the principle of mixing nitrocotton with oxidizing materials, but

the only one in use is tonite, in which the generation of carbon monoxid is reduced by the use of mineral nitrates. Such mixtures give a residue of fused salts, which, if blown out into an explosive atmosphere, are liable to cause ignition. Sprengel explosives are now largely used in blasting. They generally consist of mixtures of nitrated hydrocarbons and ammonium nitrate. Roburite is a mixture of the nitrate with nitrobenzol, and is not exploded by ordinary percussion, firing, or electric sparks, but requires a specially powerful detonator. Its gases contain no combustible products. Ammonite is made from ammonium nitrate and dinitronaphthalene. Bellite is a mixture of dinitrobenzine with ammonium nitrate, the latter in excess. Securite consists of the nitrate and dinitrobenzine, but from the proportions used the author supposes that carbon monoxid must be produced. These ammonium nitrate (Sprengel) explosives are deliquescent, and have to be kept in waterproof and airtight canisters and cartridges.

The third group consists of mixtures of the first and second classes, in which a body susceptible to detonation, and generally of an oxidizing character, is exploded, and the products made to act on a combustible. Thus westphalite consists of 95 parts of ammonium nitrate and 5 parts of specially prepared resin. Carbonite, the most important member of the group, is a mixture of about 25 parts nitroglycerine, 30 potassium nitrate, 4 barium nitrate, 40 wood meal, and 1 sodium carbonate. The admixture of so large a proportion of carbonaceous material reduces the temperature of the explosion, and therefore to that extent the liability to ignite firedamp, but on the other hand its products are largely combustible, over 40 per cent. of the gases being carbon monoxid.

The author's conclusions are that the selection of a safety explosive should be based on the following points: (1) The explosion must be due to detonation, and not to simple combustion; (2) if the explosive is a mixture, both the combustible and the oxidizing material must be susceptible of detonation; (3) the products of explosion must be non-inflammable and non-poisonous; (4) the explosive must be safe in handling as well as in action, and compounds of an unstable character which are liable to change should be avoided; (5) the temperature of explosion should be as low as is compatible with rapidity of action. These would seem to be pretty rigid specifications, but, if the author had added to them that for practical purposes a mining explosive should do its work well (that is, according to the resistance of the particular material blasted and the size of the fragments wanted), that it should be convenient to handle, and, above all, that it should be cheap, he would have described an ideal mining explosive,—which, it is needless to say, has not yet been found.

The Manufacture of Scotch Pig Iron.

IN the *Engineering and Mining Journal* (June 8) Mr. A. H. Sexton gives the history of the pig iron industry of Scotland, together with an account of the present condition of that trade. He dates the starting-point of the Scotch iron industry in 1801, when the blackband ironstone was discovered, but adds that it was 30 years or more after that before it attained any considerable importance. "Then its growth became very rapid, and for a time Scotland held the place of being the most important iron-producing country in the world. The quantity of iron produced in Scotland is little, if at all, short of what it was in the best days, but the production in other countries has enormously increased, and therefore the relative positions have entirely changed." With the great changes in iron-making all over the world, the industry in Scotland also has advanced, the introduction of the Bessemer and Siemens processes leading to the making of hematite pig, while the basic process has called for a supply of phosphoric pig, so that now the furnaces use considerable Spanish and Mediterranean ores. Two varieties of iron ore are found in the Scottish coal fields, and both are largely used. The favorite is the blackband ironstone, consisting mainly of iron carbonate, with some earthy gangue and usually enough carbonaceous matter for

calcining without the addition of other fuel. On calcination the ore loses about 30 per cent. in weight, and then contains about 50 per cent. iron. The other kind is the clayband, an iron carbonate mixed with much clay and other earthy matter. The loss in calcination is less than in the case of blackband, and the roasted ore contains about 40 per cent. of iron. The phosphorus runs high in both sorts, the analysis cited by Mr. Sexton showing 1.20 to 3.05 per cent. phosphoric acid. "Scotch pig" has always been in demand for foundry use, but the term no longer includes all, or indeed the greater portion, of the iron now made in Scotland. Limestone flux occurs in the iron district, and a fossiliferous, phosphatic limestone is used in making basic pig. The fuel is always raw coal, a splint rich in hydrogen and low in fixed carbon, and non-caking, or giving a very soft coke. The modern Scotch furnaces are similar in form to the English. They are cylindrical, cased or bound with iron, and carried on high iron columns. They are usually from 50 to 65 ft. high, with a bosh of 15 to 18 ft., having closed hearths and about eight tuyeres. Larger furnaces have been built, but the tenderness of the coal limits the height, and it has been found expedient to cut down the taller stacks, or run them only partially filled. Mr. Sexton favors a size of about 50 ft. high, with 10 ft. bosh and 8 ft. hearth. Hot blast is employed, regenerative stoves now supplanting the earlier pipe stoves.

Opal in New South Wales.

IN an essay by Mr. F. G. de V. Gipps an interesting account is given of the white Cliffs opal field and the geology of the region. The field itself is about 15 miles long, with a width of from ½ mile to nearly 2 miles, and is marked on the surface by boulders of sandstone and quartzite. Fully 95 per cent. of the opal obtained is of no value, some of it being common or semi-opal, and much, although of the noble variety, carrying the color only in minute bars or streaks, or being stained a reddish yellow by iron oxid. An unbroken vein of opal, however small, is never found, it having been broken into larger or smaller fragments, which, however, still retain their position in the vein. The fracturing is due to contraction on hardening from a gelatinous condition, the contraction having produced the internal strains of conchoidal relation to which the coloring of the opal is considered by the author to be most probably due. In addition to veins, the opal is also found in pseudomorphic forms after shells, some of these, when of good color, being very beautiful. There is a wide variety of opal on the field, and the prices paid range from zero to about $125 per ounce, though rarely above $100. In valuing opal many points have to be considered. Color is the first, red fire or red in combination with yellow, blue, and green being the best. Blue by itself is valueless, and green of no great value unless very vivid and the "pattern" good. The color must be "true," not in streaks or patches alternating with colorless stone. Pattern is an important factor, the various kinds being distinguished as "pinfire" when the grain is very small, "harlequin" when the color is in small squares, and "flashfire" when the color shows as a single flash or in very large pattern. The "harlequin" is the most uncommon and the most beautiful. The "ground" or body of the opal should be neither too transparent nor too opaque, a slightly milky, translucent sort being about the best ground. The harder the stone, the better, as, when cut, it is less likely to be injured, and it retains the polish better.

A Ball Mill in West Australia.

ALTHOUGH so many devices have been suggested and experimented with as substitutes for stamps, few are in actual service as compared with the number of stamp batteries, and, of these few, most are of a single type of roller mill, which has been found to do good work on soft ores in the United States. The description, in the *Goldfields Courier*, of a new mill (the Golden Bar) in the Coolgardie gold district, West Australia, is of interest on account of the novelty of the plant, though a record of its working would be of more value. The basis of the system is a Krupp

ball mill, nominal capacity of 30 to 35 tons a day, on ordinary quartz, crushed to 30-mesh. The shell is of wrought iron, 7 ft. in diameter by 4 ft. wide. It is lined with chilled steel plates made in sections varying in dimensions, in order that the ultimate loss of steel may be reduced to a minimum. These plates are secured by bolts, and require only a few hours for renewal. In this mill the screening arrangements are of special importance. There are three sets of screens: (1) the mantle plates, perforated by ⅜-in. holes, widening to ¾-in. on the discharge side; (2) screens of strong steel plates with 38 oblong punched holes to the sq. in.; (3) brass wire screens, in this case of 30-mesh (900 per sq. in.), but finer if needed. Each section of screens has a return, so that the ore traversing the section may be discharged as a finished product or returned to the mill for further pulverizing. It is claimed that the wear of steel is only 1½ lbs. per ton crushed to 30-mesh, and that the power required is only 18 h. p., at a speed of 21 revolutions per minute. The balls are from 3 to 5 in. in diameter, when new, and about forty (or 1 ton to 2 cwt.) are used. The amount of ore in the mill is about 15 cwt., and the operation is continuous. The mill crushes dry or wet, and, if dry, is cased in to prevent the escape of dust. It discharges into an elevator hopper.

The remainder of the plant consists of percolating vats for the cyanid process, four, with a capacity of 60 tons each, being used; the other usual adjuncts for the cyanid treatment; a set of 6-ft. Allen amalgamating pans, fitted with copper plates on the sides; a vortex pump for circulation; and an automatic mercury feed, which, by means of slow-motion gear and disc valve, allows one drop of mercury to escape each quarter turn, falling 3 ft. and striking upon a polished steel plate, which sprays it over the charge; elevators, tracks, cars, and pumps for convenient handling of the pulp, etc. The vats are discharged at the bottom; the pans are pumped out.

The World's Iron-Ore Supply.

To the forthcoming volume of "Mineral Resources," for 1894, to be issued by the United States Geological Survey, Mr. John Birkinbine contributes a chapter on the supplies, derivation, and distribution of iron ores, in which he groups the various countries under three heads: (1) Those which mine sufficient iron ore to supply their own demands, but export none, or but small amounts. The United States, Russia, Austria-Hungary, China, Japan, Brazil, and Mexico may be included in the first class. (2) Those which, while consuming domestic iron ores, are obliged to draw largely from other sources in order to obtain sufficient raw material of the required character for the iron manufactured. In this class fall Great Britain, France, and Belgium. (3) Those which, having excellent iron-ore resources, easily exploited, utilize none, or but a small proportion, by making pig or bar iron in domestic blast furnaces or forges, the bulk of the ore being exported to less favored countries. In the third class the principal countries are the German Empire, Spain, Sweden, Algeria, Cuba, Italy, and Greece. Another class might be added, to include the countries known to have iron-ore deposits of which little or no use is made, such as Tunis, Morocco, Persia, Central and Southern Africa, Venezuela, Guatemala Haiti, Servia, etc.

Coal Mining Under the Sea.

UNDER the caption "Coal Mining Up to Date," an excellent series of papers is being published in the *Iron and Coal Trades Review*, the thirteenth chapter of which appears in the *Review* of May 31. A very large part of the coal area of Durham, Northumberland, and Cumberland, England, is under the sea, and in working the principal seam of this undersea coal in Cumberland, prior to 1886, the bond-and-pillar system was followed and the pillars were left. In that year, according to our authority, the longwall method was introduced to work this seam, and it has been continued to the present time. The crown engineers have fixed the limit of working with bonds only at 21 fathoms of overhead strata from the bed of the sea; with longwall work, 45 fathoms of overly-

ing strata must be maintained; if less, the working is stopped. In one place, nearly ½ mile beyond the coast line, there is a continuous face of 600 yds., where the thickness of solid strata above is nearly 70 fathoms. The roof is strong sandstone and shale.

The Longwall System.

IN the same article of the "Coal Mining Up to Date" series, the author offers some remarks on the longwall system of getting coal, which present the whole question very clearly. It is claimed by some, or perhaps most, authorities that this method possesses several advantages over other systems. Its ruling principle, as defined by our author, is to extract the coal wholly in a continuous long face, whereby the working is greatly facilitated, a larger quantity of round coal is produced, and ventilation is much simplified. "Its greater safety is more apparent when the excavation behind can be completely filled up with *débris*, so that no lodgment of firedamp can take place; the subsidence of overlying strata and injury to coal seams above are reduced to a minimum. This filling up of the waste is obtained from taking down top in the stalls or gangways and the refuse arising from working the coal seam." It is obvious, as pointed out in the article, that thin seams, or seams of moderate thickness, lend themselves most readily to this method, as there will be an abundance of material for packwalls and complete filling. "The preliminary proceeding, in commencing longwall, is to leave large pillars at the bottom of the shaft in each seam [if more than one are to be worked], so that no crush from the subsequent working shall in any way affect the shaft. The main levels for an extensive colliery may be continued from the shaft pillars on each side, either protected by pillars of coal, or by driving out in wide work at once, every road from the shaft being a goaf road. The former method opens out the mine more quickly; the latter, though tardy, after the strata have been consolidated, generally ensures good permanent roads for haulage and ventilation. Of the main levels the two in the middle should be intakes, one for haulage and the other for traveling, those at the sides being returns from the workings right and left." There are also the systems of longwall retreating, of letting down the coal behind the workings, and various modifications and combinations of longwall with other methods not described.

Treatment of Pyritous Concentrates by Cyanid.

THE results of some interesting experiments in treating pyritous concentrates by potassium cyanid are communicated by Mr. A. T. Crosse in a paper read before the Chemical and Metallurgical Society of South Africa. Contrary to a prevalent impression that, if free acid can be neutralized, the chief source of decomposition of cyanid is removed, Mr. Crosse holds that any method leaving ferrous and even ferric hydrate in a freshly precipitated form would not answer, for cyanid takes up these hydrates to form ferro- or ferric-potassic cyanid. Working on the principle that heat dehydrates the oxids, Mr. Crosse has found what he proposes as the best method,—namely, heating the concentrates on iron plates, or by some other suitable arrangement, to a temperature just below dull red heat. After cooling, they are put in the vat and thoroughly washed with water until no iron is found by testing the wash water with potassic-ferric cyanid. Then they are washed with lime water, and leached with cyanid in the usual way, though it is recommended to let the solution percolate during the whole time of treatment.

Manganese in Georgia.

ACCORDING to a writer in the Chattanooga *Tradesman* (June 15), Georgia in the past, between 1880 and 1888, ranked second in the United States as a producer of manganese ore, Virginia holding the first place. The Cartersville district, in Bartow county, was the main producer in the State until 1891, when the Cave Spring district, in Floyd county, became a rival. Since then, shipments from both districts have been greatly reduced, owing to high freight rates to Pittsburg, the principal

market. At present, and during 1894, a revival in manganese mining has occurred. Several mines are now being worked in the Cartersville district on leased ground, at a royalty of $1 per ton.

The writer quotes, from Dr. J. W. Spencer's report as State geologist, descriptions of the geological features of the manganese districts of Georgia, adding the results of his own observations. Cartersville is now shipping from 3 to 4 tons of washed ore daily; the Cave Spring district, which shipped 3000 tons in 1890–91, is now almost idle. Other manganese localities are reported.

Manganese ore is used mainly for manufacture of spiegeleisen and ferromanganese, which are alloys of iron and manganese, employed in steel-making; for the manufacture of bronzes, and of chlorine for bleaching purposes; in decolorizing glass, and in coloring glass, pottery, and brick; and for making various chemical products.

Mining Subsidences in the Black Country.

TROUBLES similar to those met in the coal-mining regions of Pennsylvania and elsewhere in the United States, caused by the sinking of surface land undermined by colliery excavations, are not infrequent in Europe, the areas built over being, however, mainly occupied by miners' dwellings and villages of small importance as a rule. The question of liability for damages to property or loss of life and injury to persons is brought up anew by an account given in the Birmingham (England) *Post* and republished in the *Architect and Contract Reporter* (May 31) of recent happenings in the "black country," especially in the neighborhood of Quarry Bank, Stone Hill, Netherton, and other places, where a serious state of things has been brought about by mining operations. In some of these towns and villages dwellings intact are almost a novelty, except where residences have had to be rebuilt, or in the very rare cases where the mines have been purchased by the owners of surface property. Laws enacted in the time of George III, when most of the coal lands now more or less densely populated lay waste, gave to the "lord of the manor" power not only to do anything he liked with the coal within certain specified inclosed areas, but also to "soil" underneath the "common water, land, and other things," without being liable for compensation; but, as a kind of set-off to these almost unlimited privileges, there is a clause stating that he must "do as little damage as may be." This very indefinite restriction has been made the basis of suits in equity, but litigation for damages has made no practical progress. "Apart from the overwhelming legal difficulties surrounding the matter," says the *Post*, "the whole question of compensation is beset with great and conflicting interests. On the one hand are the interests of the miners, the ironworkers, and of all who desire that the collieries should be worked thoroughly, and on the other hand the interests of the owners of houses." In other parts of the district outside the "inclosed areas" of the acts and where the "lord of the manor" is subject to common law, the custom is for him to erect a new house for every one destroyed. As to the "inclosed areas," the *Post* suggests a compromise arrangement, by which the owners of colleries should contribute a portion of the cost of repairs and renewals.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*32408. The Magnetic Separation of Iron Ores.—Scientifically and Commercially Considered. Clinton M. Ball (Eng Mag-Aug.) 3500 w.

*32422. The Sheffield Steel Industry. R. A. Hadfield (*Ir & Coal Tr Rev*-May 31.) 2400 w.

32432. The Manufacture of Scotch Pig. A. H. Sexton (Eng & Min Jour-June 8.) 1300 w.

32433. The Chemist and the Blast Furnace. William B. Phillips (Eng & Min Jour-June 8.) 800 w.

32441. Manufacture of Steel Projectiles in Russia. Sergius Kern (Am Mfr & Ir Wld-June 7.) 500 w.

32460.—$1.50. Specifications for Structural Steel. H. H. Campbell, with Discussion and

We supply copies of these articles. See Introductory.

Correspondence (Am Soc Civ Eng–April.) 37000 w.

32505. The Chemistry of Pig Iron and Its Application to Casting for Electrical Purposes. B. S. Summers (Elec Engng–June.) 2400 w.

32507. Extraction of Gold by Electrolysis. A. J. Rogers (Elec Engng–June.) 1500 w.

32542. Natural or Suction Draft Cupolas. Ill. Thomas D. West (Ir Tr Rev–June 13.) 4200 w.

32556. Early Iron Making in North Carolina. Ill. J. D. Kase (Eng & Min Jour–June 15.) 400 w.

32557. Treatment of Pyritous Concentrates by Cyanide. A. T. Crosse (Eng & Min Jour–June 15.) 900 w.

32604. Blast Furnace Construction and Working in Upper Silesia. A. Gouvy (Am Mfr & Ir Wld–June 14.) 1100 w.

32605. Compressed Air: Its Utility and Advantages as Applied to Foundry Purposes. Howard A. Pedrick (Am Gas Lgt Jour–June 17.) 3000 w.

†32619. The Strength of Iron as Affected by Tensile Stress While Hot. De Volson Wood (Am Soc Mech Eng–June.) 250 w.

†32639. The Lixiviation of Silver-Ores by the Russell Process at Aspen, Colorado. Willard S. Morse (Tr Am Inst Min Eng–June.) 3600 w.

†32641. The Assay of Silver Sulphides. H. Van F. Furman (Tr Am Inst Min Eng–June.) 1400 w.

†32644. Milling Arizona Gold-Ores with a "Colorado" Stamp-Mill. Ill. Willard S. Morse (Tr Am Inst Min Eng–June.) 1200 w.

†32645. Treatment of Roasted Gold-Ores by Means of Bromide. Richard W. Lodge (Tr Am Inst Min Eng–June.) 700 w.

†32646. Nickel and Nickel Steel. Remarks in discussion of Paper of F. L. Sperry by John Birkinbine (Tr Am Inst Min Eng–June.) 1000 w.

†32647. The Present Limitations of the Cyanide Process. C. W. Merrill (Tr Am Inst Min Eng–June.) 1400 w.

†32649. A New Slag-Car for Lead and Copper Blast-Furnaces. Carl Henrich (Tr Am Inst Min Eng–June.) 2200 w.

†32651. The Cyanide Process as Applied to the Concentrates from a Nova Scotia Gold-Ore. Richard W. Lodge (Tr Am Inst Min Eng–June.) 800 w.

†32653. Assays of Copper and Copper Matte. Discussion (Tr Am Inst Min Eng–June.) 12000 w.

32670. The Place of Iron in Nature. John T. Kemp, in Knowledge (Sci Am Sup–June 22.) 1400 w.

*32717. Recent Progress in Siemens-Martin Furnace Construction. Ch. Walrond (*Col Guard*–June 14.) 2000 w.

32742. The Proposed Iron and Steel Scale (Ir Tr Rev–June 20.) 900 w.

32771. On Scheibler's Modification of the Basic Bessemer Process. E. Schrodter (Am Mfr & Ir Wld–June 21.) 700 w.

32774. Joseph Hall's Process for the Manufacture of Aluminum. Ill. (Eng & Min Jour–June 22.) 1100 w.

32790. Keep's Cooling Curves.—A Study of Molecular Changes in Metals Due to Varying Temperatures. W. J. Keep (Ir Age–June 27.) 2400 w.

32857. The Rate of Solution of Gold in Cyanide Solutions. A. W. Warwick (Eng & Min Jour–June 29.) 1400 w.

*32863. The Manufacture of Tin-Plate in Austria (*Bd of Tr Jour*–June.) 2200 w.

*32889. Cleaning and Concentrating Outcrop Iron Ores. Walter J. May (*Col Guard*–June 21.) 2200 w.

*32890. Technical Progress Realized in the Production of Pig Iron in Germany and Luxemburg Since 1882. M. Van Vloten (*Col Guard*–June 21.) 4000 w.

*32891. A Competitive Trial of Flue-Heated Coke Ovens. A. Hüssner (*Col Guard*–June 21.) 500 w.

32950. Some Notes on the History of Electro-Smelting. Ill. Alfred H. Cowles (Pro Age–July 1.) 3400 w.

32973. The Ohio Steel Company's Plant at Youngstown, Ohio. Ill. (Sci Am Sup–July 6.) 1300 w.

*33049. The Slavianoff Electric Metal-Casting System. Ill. (Abstract.) A. Lohmann (*Col Guard*–June 28.) 1500 w.

*33051. The Great Western Railway Works, Swindon. Ill. (*Eng*–June 28.) 3200 w.

*33074. The Iron Industry of New South Wales. Editorial (*Ir & Coal Tr Rev*–June 28.) 1800 w.

Mining.

*32412. Mining Subsidences in the Black Country. From the Birmingham Post (*Arch*–May 31.) 2000 w.

32430. The Gold Belts of Nevada. Dan De Quille (Eng & Min Jour–June 8.) 1800 w.

32450. The Ward District.—Boulder Co., Col. Ill. Howard R. Burk (Min Rev–June 7.) 2500 w.

*32568. Mining Explosives. Vivian B. Lewes, with Discussion (*Col Guard*–June 7.) 4800 w.

*32569. Electric Coal-Cutting at Glenclelland Colliery. Ill. George A. Mitchell (*Col Guard*–June 7.) 3500 w.

*32570. Causes of Explosion in Lignite Briquette Factories. Rudolf Holtzwart and Ernst von Meyer (*Col Guard*–June 7.) 1500 w.

*32580. Mine Sampling. Editorial (*Min Jour*–June 8.) 1500 w.

*32586. Gold in Scotland (*Fairplay*–June 7.) 1700 w.

32597. Manganese in Georgia. Anon. (Tradesman–June 15.) 2200 w.

†32637. The Ducktown Ore-Deposits and the Treatment of the Ducktown Copper Ores. Ill. (Tr Am Inst Min Eng–June.) 22500 w.

†32638. Notes on a Southern Coal-Washing Plant. Ill. J. J. Ormsbee (Tr Am Inst Min Eng-June.) 3500 w.

†32640. Hysteromorphous Auriferous Deposits of the Tertiary and Cretaceous Periods in New Zealand. Henry A. Gordon (Tr Am Inst Min Eng-June.) 3800 w.

†32642. The Albion Phosphate District. E. T. Cox (Tr Am Inst Min Eng-June.) 1500 w.

†32643. Mining Leases. Francis I. Freeland (Tr Am Inst Min Eng-June.) 2200 w.

†32650. The Northeastern Bituminous Coal-Measures of the Appalachian System. George S. Ramsay (Tr Am Inst Min Eng-June.) 3000 w.

†32652. The Florida Rock-Phosphate Deposits. G. M. Wells (Tr Am Inst Min Eng-June.) 2800 w.

32664. The Canadian Nickel Mines. (Ir Age-June 20.) 1700 w.

*32714. Experiments with Explosives. Begassessor Winkhaus (*Col Guard*-June 14.) 4800 w.

*32715. The Leinster Coal-field. R. Sutcliffe (*Col Guard*-June 14.) 2200 w.

*32716. The Aniche Collieries, Nord, France. (*Col Guard*-June 14.) 1600 w.

*32718. Experiments in Mine Ventilation. R. Hausse (*Col Guard*-June 14.) 700 w.

*32760. The Necessity for Competent Geological Surveys of Gold Mines. Nicol Brown (*Min Jour*-June 15.) 2000 w.

32772. Cost of Electric Coal Cutting in Scotland. Statements of George A. Mitchell (Am Mfr & Ir Wld-June 21.) 1700 w.

32773. Porphyry. T. A. Rickard (Eng & Min Jour-June 22.) 1100 w.

32811. Timbering in the Isabella Incline. Francis T. Freeland (Min & Sci Pr-June 22.) 800 w.

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*32887. The Remuneration of Mine Surveyors in Germany. (*Col Guard*-June 21.) 800 w.

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*32899. Remarks on the Banket Formation at Johannesburg. A. R. Sawyer (*Min Jour*-June 22.) 2700 w.

*32900. The Murchison District, W. A. Brenton Symons (*Min Jour*-June 22.) 4500 w.

*32902. Chrome Iron Ore Mining in Asia Minor. W. F. Wilkinson (*Min Jour*-June 22.) 1800 w.

†32987. Coal Mining in Australia. D. (*Ind Engng*-June 1.) 900 w.

32988. Estimating Mine Values. Editoria (Min Ind & Tr-June 27.) 1200 w.

33010. Gold Mining in Southern States—Present Conditions and Future Prospects. W. M. Brewer (Tradesman-July 1.) 1500 w.

*33047. Methods of Dealing with Coal Dust. Anon. (*Col Guard*-June 28.) 3500 w.

*33048 Mine Regulations in the Bonn Inspection District, with the 1895 Modifications and Additions. (*Col Guard*-June 28.) 6300 w.

Miscellany.

32429. Remarks on the Recent English Decision in the Cyanide Case. C. W. Merrill (Eng & Min Jour-June 8.) 1500 w.

Serials

22586. The Mineral Hydro carbons. Henry G. Hanks (Min & Sci Pr-Began June 2, 1894—29 parts to date—15 cts. each).

27329. Coal Mining Economy Up to Date. Anon. (*Ir & Coal Tr Rev*-Began Nov. 23, 1894—17 parts to date—30 cts. each).

28932. Cripple Creek Phonolite Dikes, Raven Hill. Edward Skewes (Eng & Min Jour-Began Feb. 2—3 parts to date—15 cts. each).

29599. Mining in Spain (Asturias) (*Min Jour*—Began Feb. 16—4 parts to date—30 cts. each).

30461. The History of Iron. Notes from Dr. Ludwig Beck (Ir Age—Began March 28—7 parts to date—15 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishaw. Ill. (*Engng*-Began April 15—Ended June 28—5 parts—30 cts. each).

31793. The Commercial Use of Minerals. Norman Danvers Power (*Aust Min Stand*-Began April 13—Ended May 4—4 parts—30 cts. each).

31908. Victorian Gold Mining. Thomas Cornish (*Min Jour*-Began May 11—6 parts to date—30 cts. each).

32574. Recent Improvements in Galvanizing. Ill. (*Eng*-Began June 7—1 part to date—30 cts).

32579. Coolgardie. Brenton Symons (*Min Jour*-Began June 8—2 parts to date—30 cts. each).

32770. Swedish Iron Ores. From Report of John Birkinbine (Am Mfr & Ir Wld-Began June 21—2 parts to date—15 cts. each).

32901. The Rand Conglomerate. M. Draper (*Min Jour*-Began June 22—Ended June 29—2 parts—30 cts. each).

32979. Silver Mining and Smelting in China (*Ind & East Eng*-Began June 1—1 part to date—45 cts).

33071. On Deep Mining in Mexico. Edward Halse (*Min Jour*-Began June 29—1 part to date—30 cts).

33072. The Copper and Tin Deposits of Chotanagpore, Bengal, India. Robert Oates (*Min Jour*-Began June 29—1 part to date—30 cts).

MUNICIPAL ENGINEERING

Bacteria and Other Organisms in Water.

AN exceedingly interesting and instructive paper on this subject, read April 17 before the American Society of Civil Engineers, by John W. Hill, and printed in the May number of the *Transactions*, elicited a discussion scarcely less instructive than the paper itself, in which debate some of the most prominent engineers in the country joined. An attempt to give here anything more than an outline of this paper and the remarks made upon it would fail. The paper itself comprises a large amount of tabulated information, and is illustrated with plates delineating a considerable variety of living and dead floating impurities found in water, including algæ, diatoms, desmids, rhizopods, infusoria, etc., with other miscellaneous solid impurities. Accounts of examinations of water, filtered and unfiltered, supplied to cities for potable and domestic use occupy considerable space.

"In making tests for the bacteria in water, the method pursued by the author has been to collect the water in carefully-sterilized 2 oz. glass-stoppered bottles, enclosed in small sterilized tin canisters, and to inoculate the gelatine or agar plates with one or more drops of the water under examination, and then, after mixing the water and melted media, heating the mouth of the tube, and singing the cotton plug to destroy any chance organisms, to pour the solution of nutrient media and water into a sterilized Petri dish. Usually from 6 to 10 cu. cm. of gelatine or agar is used, and the number of drops of water from a sterilized pipette depends upon the extent of pollution, or, rather, the number of bacteria suspected in the water. From a very polluted water one drop, or $\frac{1}{18}$ cu. cm., is too much, the number of bacteria present being so great as to be innumerable by the Wolffhugel method, and absorbing the nutrient media so completely as to prevent the growth of some varieties. In such cases, after shaking the bottle containing the sample of water under investigation, it is customary to dilute this several times with sterilized water and multiply the actual count of bacteria accordingly. With comparatively pure natural waters (which are, unfortunately, rarely found) $\frac{1}{4}$, $\frac{1}{2}$, or 1 cu. cm. is used for inoculation purposes; a single drop from one of the ordinary dropping-tubes, or pipettes with rubber tops, may contain from $\frac{1}{18}$ to $\frac{1}{24}$ cu. cm., and, after the use of one of these, it must be measured to determine the proportion of a cubic centimeter used in the inoculation. The period of incubation which has been allowed is 5 days at room temperature, except with filtered waters, when the time has been extended from 10 days to 2 weeks or more. The growth of bacteria is rapid in polluted water, and, if liquefying organisms are present, as they generally have been in the waters experimented with, the count must not be delayed beyond 4 or 5 days, or the liquefiers will spread over the plate and obscure some of the non-liquefying colonies. It is a noticeable fact in the author's experience that plates inoculated with water from the best type of filters require more time for the incubation of the colonies of bacteria than those with unfiltered water. Thus the germs left in the water after filtration grow at a slower rate than many that are in the water before filtration. From which it would follow that in counts of plates of unfiltered water at the end of a few days some bacteria are very liable to be overlooked because they have not grown. This may have no significance, but it is well known that the typhoid bacillus is comparatively a slow-growing germ, and might be obscured on an ordinary growing plate. While the growth of many of the bacteria is much slower at room temperature subject to variations than in the incubator, where the temperature is maintained quite constant, still the rapid-growing liquefying germs in the incubator are frequently seen to spread

and obliterate the non-liquefiers, and destroy the germs of slow growth altogether."

Among the waters thus examined were samples from the public mains of Cincinnati and Jersey City. Quotations from reports of examinations of water taken from European water supplies, as made by eminent scientists, were liberally made. One of the most interesting parts of the paper to the popular reader is a report of an examination of Apollinaris water.

"Apollinaris water is regarded everywhere as the 'queen of table waters,' and is in such demand for drinking purposes that in our country it commands a price of from 75 cents to $1 per gallon,—a very high price indeed for even an absolutely pure drinking water. Recognizing the extent to which this water is used for drinking purposes, and having a curiosity to know more about it, the author recently made three plate cultivations on gelatine from a fresh unopened bottle of Apollinaris water with the following results:

"Plate I, 1984, plate II, 1728, plate III, 2112 bacteria per cubic centimeter. The standard for the filtered water from the London water works has been stated as 100 bacteria per cubic centimeter, and the number has been so low as 18–20 per cubic centimeter, and upon one occasion absolutely sterile water was reported. Before inoculating the gelatine with the Apollinaris water, great care was taken to heat the neck of the bottle and scorch the cork before the wires holding it in the bottle were cut; and, everything being in readiness, the inoculations were quickly made.

"While the number of germs in the Apollinaris may be more or less (probably less by the inhibiting action on the growth of bacteria of the 'carbonic acid gas' in the water) than when originally bottled, still this is the condition in which we drink it when taken from freshly-opened bottles. Among the organisms found on the gelatin plates was Cladothrix dichotoma, which is usually held to indicate the presence of considerable organic matter in water. The water reacted quite alkaline, and it would therefore be good breeding material for most water bacteria, especially the cholera bacillus.

"The spring from which this well-known water is obtained is located in the valley of the Ahr, in Rhenish Prussia, and is said to have a capacity of 27,400 United States gallons per day, while the present output of bottled water amounts to 12,330 gallons per day. A number of chemical tests have been made of Apollinaris water, but from the information available it seems not to have been tested for bacterial life before."

A statement made by Mr. Hill that typhoid can be propagated only through drinking water was challenged, in the discussion following the reading, by Mr. Rudolph Hering, who stated that this view is opposed by numerous high authorities. He stated the two prevailing theories, "the drinking water theory" and "the ground water theory," each of which has numerous supporters; and, while admitting that most cases of typhoid are propagated by drinking water, he asserted positively that "there are other means of disseminating this disease."

Natural Gas a Pioneer for Artificial Fuel Gas.

NATURAL gas is treated from the standpoint of the above title by Mr. Donald McDonald in a paper read at the eighteenth annual meeting of the Western Gas Association, Pittsburg, May 16, and printed in *American Manufacturer* (May 24). After having been taught the advantages of gaseous fuel, the author regards it as certain that its users will never return to coal, and, natural supplies failing, they will resort to artificial fuel gas. He, moreover, regards it as certain that the future demand for gas as fuel will be tenfold that of gas for illumination. Natural gas has taught thousands of people the inestimable advantages of gaseous fuel, and it is safe to say that, having once learned this lesson, they will never willingly return to the use of coal. It has also demonstrated the fact that the demand for gas for fuel will be at least ten times that of gas for light. It has also supplied the means for many thousands of very cheap experiments on gas-appliances. The net result of this is that these appliances have been improved to such an extent that peo-

ple can now afford to pay 40 cents a thousand for gas, where formerly they found it too expensive at ten cents a thousand. Of course, if artificial gas had attempted to enter the field of domestic heating during the early period of these experiments, it would have been impossible to furnish either satisfaction to the consumer or profit to the company. Now, however, the case is far different. The experiments have been tried, the houses are piped, the connections made, the meters set, and, more than this, the prejudices of consumers have been overcome, and housewives have learned that a gas fire is less dangerous than a coal fire, and that it means the difference between comfort and drudgery. Any artificial gas company which had attempted to perform this pioneer work in a city as large as Pittsburg would have lost hundreds of thousands of dollars before it had brought the matter to the favorable condition in which it now is.

"It is safe to say that, if natural gas were to fail to-morrow in any city where artificial gas could be had as cheap as 80 cents a thousand, the demand on the artificial gas would immediately show a marked increase. The kitchens, the bath-rooms, and, in many cases, the parlors would continue to use the gas-stoves which they have already set. If artificial gas could be had as low as 50 cents, we would find added to this list many of the dining-rooms, and many best rooms, which are not used as sitting-rooms."

There still remains something to be done by the companies who would create and increase a demand for fuel gas. They must "prepare for fuel at as low a figure as is consistent with a fair profit on their investments, and, in arriving at this figure, they must leave out of the fund on which interest is to be paid all reference to the fact that iron pipe once cost $100 a ton, that much of it that was laid proved to be useless and had to be replaced, or that opposition companies have been bought out at large cost, and their works allowed to lie idle."

These things may be burdens on the old line companies, but they will not be burdens "on companies that may be organized"; and, if a general demand for fuel gas at the price named is created, that demand will be met by new companies, if the older companies do not supply it.

"In figuring on the possibilities of cheap gas in this connection, it must be remembered that all of the items usually included under the head of cost of gas per thousand in the holder would be considerably reduced if the output of the gas were increased tenfold." While these items, included under the head of distribution, general expense, depreciation, and management, will be increased very little for the same number of consumers over what they are now, the cost per thousand will be very greatly cut down.

"I will not say in this paper how I believe it possible for a large volume of gas for fuel and light to be sold. It is a figure which will vary greatly in each locality, but I do believe that it is possible to bring the figure down so low that the wealthier class of people can afford to use gas to the entire exclusion of coal, while those not so fortunate will find a large use for it in their less constant fires"

But not only must the fuel be cheapened; cheaper and better fixtures must be supplied for burning it. The products of combustion must not be allowed to escape into rooms in which gas-stoves are used for warming, except for short periods. Continuous escape of such products becomes a nuisance after a short time. The water vapor condenses on walls and windows, and on cold furniture, to everybody's discomfort, and there is also a danger that the carbonic acid gas may sometimes travel along with others more injurious. Means must therefore be provided for conveying these products into the outside air, after extracting nearly or quite all their heat from them.

Disposal of City Waste.

A PAPER by Col. George E. Waring, Jr., commissioner of street cleaning of the city of New York, in *The North American Review* for July, deals with this important subject. At the outset it is stated that, "while the theoretical value of discarded matters is recognized, the cost of recovery

is still an obstacle to its profitable development." Separation of the manure from the very large amount of water contained in sewage cannot by means now known be effected profitably. This seems to be a sweeping statement as against current schemes for the disposal of sewage considered as a commercial business. However, there are other wastes in cities, the utilization of which is not embarrassed with the presence of great bodies of water, and which admittedly promise profit sufficient "to make it worth while to consider them and their possible value with a good deal of care and to make them the subject of conclusive experiment." These wastes are found in the general mass usually classed as garbage, ashes, and street-sweepings. From these "Italian workmen fish out such as they can of the rags, bones, bottles, and other things of value that the material may contain. Each of the fifteen dumps [in New York] is worked by its own gang for its own padrone, and these pay to the general contractor enough more than he has to pay to the city to leave him a satisfactory profit. These scow-trimmers were paid $10.50 per week each until 1878, since which date no charge has been made for labor, the recovered matter being accepted as payment. Beginning with 1882, the privilege of scow-trimming brought to the city a money compensation of from $75 to $90 per week. The payment increased gradually, until in 1887 it reached $320 per week; in 1888, $685; in 1889, $1000; in 1890, $1068; in 1891, $1770; in 1892-93, 1795. At the end of 1894 it had fallen to 1675. There were occasional deductions on account of the temporary closing of the dumps, but for some years the city has received annually over $50,000 worth of labor and about $90,000 in cash as the value of the privilege of gleaning its dust chutes." The articles obtained are rags of various qualities; soft wools; rubber; soda-water bottles; lager-beer bottles; seltzer-water bottles and bottles of other sorts; iron; zinc; copper; brass; pewter; paper; tomato cans (for the solder); old shoes; hats; broken glass; carpets; rope; brushes; fat; hemp twine; and cloth. The prices obtained by the gleaners for these articles are named. The system of collecting, must, from necessity, be very imperfect, and Col. Waring thinks that the "public authorities might with advantage take control of the whole business."

"Such control would involve the suppression, or the public employment, of the push-cart man, who jingles his string of bells through the streets and carries on a more or less illicit traffic with domestic servants. These peddler-buyers are no more tolerable than were the long-ago discarded rag-pickers. Those who have cast-off things to sell should be made to take them to licensed located dealers, whose transactions can be held under proper supervision. The municipality should—in the interest of the public safety, as well as of the public finances—take up and carry on for itself, or through contractors whom it could control completely, the whole business of removing from houses whatever householders may wish to get rid of and will not take the trouble to carry for sale to a dealer."

Without making any precise calculation (which would be manifestly impracticable) Col. Waring estimates that the amount so collected would reach a value per year of something over $7,000,000, "enough to pay all the cost of street cleaning and street sprinkling, and, in addition thereto, to repave the whole city within a very few years, so far as this is needed, and to keep the pavement in repair perpetually. And he thinks "that in due time it would pay for a complete supply of public urinals, latrines, and other items of municipal housekeeping." This estimate is based upon the supposition that wastes of the kind considered will amount to 1 cent per day per person on the average.

The paper further deals with methods of collection and treatment of rubbish and garbage in general, and advocates the separation, and separate collection, of paper and other like rubbish, street-sweepings, garbage, and ashes; and maintains that it is only because "each one of these classes bedevils all the others that final disposal is such a serious problem.

"Paper, rags, and rubbish of every kind should be collected only by the city's own carts, or the city's own contractors. . . . . Paper and all manner of dry rubbish being rigidly kept in-doors until taken by the collector, the sweepings of the streets—especially after the improved repaving—will consist of little else than horse-droppings; and, while these have not much commercial value in New York, they can at least be got rid of inoffensively and without much cost. . . . As soon as the separation is fairly accomplished, contracts will be made for the reduction, utilization, or cremation of the garbage. . . . As to the disposal of ashes, this separation will render them such a good material for filling of lands under water that there will no longer be any necessity for carrying them out to sea." In conclusion, Col. Waring expresses the view "that, while the question of the disposal of a city's wastes is full of difficulty, it is also full of promise."

THE danger of relaxing restrictions established for the purpose of preserving the beauty of public pleasure-grounds has been recently exemplified in Central Park, New York. This episode is briefly narrated and editorially commented upon in *Garden and Forest* (June 12). A larger liberty of access to the areas was allowed, and the familiar signs, "Keep off the Grass," were removed in some places. It is asserted that the park has suffered serious defacement since the relaxation of a time-honored restriction. The "shrubs and herbaceous plants in bloom were broken and carried away by the armful, in spite of the police."

"A significant fact was stated by a park policeman, who said that for the first few days after the lawns were thrown open people could hardly be persuaded to walk on them. Those who frequented these portions of the park had become so accustomed to walking on the paths and sitting on the benches that they had to be invited to walk in and sit down on the grass before they would accept what was considered such a favor. Of course it did not take long to educate people up to their new privileges; but the fact that they had already been educated to keep off the grass is certainly worth considering."

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

32439. The Storage and Handling of Oils in a Gas Works. D. J. Collins, with Discussion (Am Gas Lght Jour-June 10.) 7600 w.

*32489. "Slopers" at Brentford (*Jour Gas Lgt*-June 4.) 1900 w.

*32552. Test of the Welsbach Incandescent Gas Burner. E. V. Stebbins (Sib Jour Eng-June.) 1500 w.

*32727. The Monier System of Cement Construction as Applied to Gas-Works. Ill. F. D. Marshall, with Editorial and Discussion (*Jour Gas Lgt*-June 11.) 9000 w.

32768. Gaseous Fuel in the Retort House. Ill. T. S. Cleminshaw, in the London Journal (Am Gas Lght Jour-June 24.) 2200 w.

32780. Making Working Diagrams for Gas-Pipe. Ill. W. B. Gray (San Plumb-June 15.) 5700 w.

*32791. Some Improvements in the Methods of Manufacturing Sulphate of Ammonia. C. Stafford Ellery, with Discussion (*Gas Wld*-June 15.) 3800 w.

*32792. Illumination. W. Ivison Macadam, with Discussion (*Gas Wld*-June 15.) 4500 w.

*32793. Photometry as Applied to the Verification of the Illuminating Power of Gas Supplied to Towns. Ill. William Sugg (*Gas Wld*-June 15.) 5000 w.

*32794. Unaccounted for Gas. D. Irving, with Discussion (*Gas Wld*-June 15.) 7000 w.

*32795. The Practice of Districting with a View to the Equalization of Pressure. F. W. Cross (*Gas Wld*-June 15.) 4200 w.

*32796. Acetylene and the Part it Plays in the Luminosity of Flame. Vivian B. Lewes (*Gas Wld*-June 15.) 6000 w.

*32797. The Combustion of Coal Gas for Fuel Purposes. Vivian B. Lewes, with Discussion (*Gas Wld*-June 15.) 6000 w.

*32799. The Management of, and Remuneration to, Gas Workers. John M'Crae, with Discussion (*Gas Wld*-June 15.) 5000 w.

*32800. On Some Matters of Interest in Connection with the Washing of Crude Coal Gas. Lewis T. Wright, with Discussion (*Gas Wld*-June 15.) 5300 w.

*32801. Electricity Supply from Town Gas. F. H. Medhurst, with Discussion (*Gas Wld*-June 15) 5000 w.

We supply copies of these articles. See introductory.

*32802. Notes on Luminous and Non-Luminous Combustion. B. H. Thwaite (*Jour Gas Lgt*-June 18.) 3000 w.

*32915. Notes on Experiments with Liquid Gas Enrichers. T. Stenhouse (*Gas Wld*-June 22.) 1400 w.

*32916. Manufacture of Cyanides. From Mr. Heller's Report on the Chicago Exposition (*Gas Wld*-June 22.) 1100 w.

32941. Cumulative Generators in Soft Coal Gas Making. Ill. James L. Hastings (Am Mfr & Ir Wld-June 28.) 3000 w.

32942. Testing Prepared Tar. C. Lunge (Am Mfr & Ir Wld-June 28.) 1400 w.

32944. Inaugural Address of President Robert Mitchell before the Thirty-second Annual Meeting of the Incorporated Gas Institute (Am Gas Lgt Jour-July.) 5000 w.

Sewerage.

*32895. Sewage Purification. Ill. Charles H. Beloe (*Ind & Ir*-June 21.) 2000 w.

Streets and Pavements.

32503. How to Make a Good Paving Brick. Prize Essay by George W. Kummer (Brick-June.) 2800 w.

32856. Street Work, Boston, 1894 (Eng Rec-June 29.) 2400 w.

*32961. Asphalt Pavements in New York (Paving-July.) 1200 w.

*32962. California Asphaltum and Bituminous Rock. Clifford Richardson (Paving-July.) 3200 w.

33025. How to Make a Good Paving Brick. T. Townsley (Brick-July.) 2200 w.

Water Supply.

32442. Water Works and Their Management. L. M. Case, with Discussion (Fire & Water-June 8.) 6800 w.

32459.—$1.50. A Line of 28-in. Cast-Iron Submerged Pipes Across the Willamette River, at Portland, Ore. Ill. Franklin Riffle and Albert S. Riffle, with Discussion (Am Soc Civ Eng-April.) 15500 w.

32553. Some Practical Experience with a Meter System. J. B. Newhall (Fire & Water-June 15.) 1600 w.

32737. The Ipswich, Mass, Water-Works (Eng Rec-June 22.) 900 w.

32786.—$1.50. Bacteria and Other Organisms in Water. Ill. John W. Hill, with Discussion and Correspondence (Am Soc Civ Eng-May.) 14000 w.

*32803. Hydraulic Lifts on the Water Supply System of Cologne. (Abstract.) Herr Froitzheim (*Jour Gas Lgt*-June 18.) 1500 w.

32873.—75 cts. Some Observations on the Temperature of Surface Waters; and the Effect of Temperature on the Growth of Micro-Organisms. George C. Whipple, with Discussion (Jour of New Eng Water Works-June.) 8000 w.

32874.—75 cts. An Experience with Anchor Ice and a Recording Pressure Gage. Charles W. S. Seymour (Jour of New Eng Water Works-June.) 1400 w.

32875.—75 cts. How to Reduce the Excessive Consumption of Water. J. C. Haskell-with Discussion (Jour of New Eng Water Works-June.) 4800 w.

32876.—75 cts. A Description of the Water Works at Webster, Mass. Frank L. Fuller (Jour of New Eng Water Works-June.) 2500 w.

32933. Our Experience with Water Meters. John B. Heim (Fire & Water-June 29.) 1800 w.

*32960. Pure Drinking Water for Cities. Frederick A. Kummer (Paving-July.) 1500 w.

†32978. The Rajkat Water Works, Bombay. Robert Bell Booth (*Ind & East Eng*-June 1.) 1900 w.

Miscellany.

32521. The Defacement of City Parks. Editorial (Gar & For-June 12.) 1600 w.

*32606. Dwellings of the Poor. Alderman Cortis (*San Rec*-June 7.) 3800 w.

†32618. A Portable Disinfecting Plant. Ill. W. H. Francis (Am Soc Mech Eng-June.) 700 w.

32695. The Carson-Trainor Trench Machine. Ill. (Eng News-June 20.) 1500 w.

32782. The Municipal Water Works and Electric Light Plant of North Attleboro, Mass. Ill. (Elec Eng-June 26.) 700 w.

*32798. The Transfer of Gas and Water Undertakings to Public Authorities. William Newbigging, with Discussion (*Gas Wld*-June 15.) 3500 w.

†32822. The Disposal of a City's Waste. George E. Waring, Jr. (N Amer Rev-July.) 3000 w.

*32963. Progressive Municipal Work in Philadelphia. Ill. Anon. (Paving-July.) 1100 w.

*33017. The Progress of Municipal Reform, 1894-5. Clinton Rogers Woodruff (Am Mag of Civ-July.) 3200 w.

33026. The New York Botanical Garden. Editorial (Gar & For-July 3.) 1200 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News-Began July 14, 1892—48 parts to date—15 cts. each).

30971. Gas Power in the American Market. Ill. (Pro Age-Began April 15—6 parts to date—15 cts. each).

31082. Water Supply and Pipe Distribution. F. C. Moore (Fire & Water-Began April 20—8 parts to date—15 cts. each).

31701. Fires and Fire Engines in the Olden Times. William Perry (Can Eng-Began May—2 parts to date—15 cts. each).

32538. Simple Methods for Solving Problems Relating to the Flow of Gas in Pipes. William Cox (Pro Age-Began June 15—Ended July 1—2 parts—15 cts. each).

32575. Some Figures Relative to the Cost of Producer Gas. W. H. Booth (*Elec Rev*-Began June 7—Ended June 14—2 parts—30 cts. each).

RAILROADING

Counter-Balancing Locomotives.

THIS subject is still under active debate. In our April number we reviewed an article by Mr. Geo. S. Morrison in *The Railroad Gazette*. In our June number we also reviewed an editorial in the same paper (April 12), in which it was asserted that "no one has been able to show that the use of two cranks at right angles makes it impossible to prevent injury to the tracks." Others joined in the debate. Mr. Morrison's opinion that the only way to perfect a balance and thus avoid injury to track is to use four-cylinder locomotives with cranks set at 180° was attacked. In reply Mr. Morrison sent a letter to the editor of *The Railroad Gazette* (printed June 14), in which he says:

"Referring to the matter of counterbalancing, and especially to the ground that has been taken by Mr. Barnes and others, the whole matter of the effect of counterbalancing reciprocating parts by revolving parts may be briefly stated. It is impossible to counterbalance reciprocating parts in this way without introducing a vertical disturbance which materially increases the pressure on the rails over what it would be if this vertical disturbance was not introduced. It is undoubtedly possible to build a track to stand this increased vertical pressure. On the other hand, it is not economical to build such a track, and it has never yet been done. If the motive-power department wishes to build the cheapest engine possible, it is for its interests to use engines for the class now running. If the maintenance-of-way department wishes to build and maintain the cheapest track consistent with traffic, it must get rid of the disturbances now caused by counterbalancing. If the general manager of a railroad wishes to get the best results from the whole rather than from a single department, he must take these two conditions into consideration, and the result will be the use of a more expensive locomotive which will make it possible to save enormously in the cost and maintenance of track."

Upon this the editor of the paper quoted commented editorially at length, in the same issue, the subject being important, and Mr. Morrison being an eminent engineer, whose views, though at variance with those of his critics, command respect. This editorial substantially concedes Mr. Morrison's proposition that "it is impossible to counterbalance a locomotive [two-crank locomotive?] so that there will be no vertical disturbance; but," it goes on to say:

"Whether it is or is not economical to build such a track" as will stand this disturbance, and whether it has or "has never yet been done," will remain open questions until facts are collected that show conclusively that locomotives balanced on the common plan and run at ordinary and reasonable speeds either do or do not injure the track more than will be allowed by general managers, who are bound to get the best results from the whole rather than from a single department. What is most needed now is evidence on this specific question from a track standpoint; and, until facts presented show that, under normal conditions, track is damaged seriously by locomotives, those who claim that the effect on the track can be enough reduced by proper designs of reciprocating parts will have the weight of argument on their side.

In this editorial, reference is also made to an eight-wheel 19-in. cylinder locomotive described in the issue of May 17, built at the Schenectady Locomotive Works for the Delaware and Hudson Canal Company, and it is said that this locomotive "is an example of lightened reciprocating parts that may be taken as a perfectly practical plan of construction, which, while not the lightest possible, is easily reached." It has 68-in. drive-wheels, and can run 70 miles per hour. "This locomotive will ride well, if 250 lbs. of weight is left un-

balanced on each side. This amount has been determined from the practical working of a large number of locomotives of this weight. The weight of the piston, cross-head, and part of the main rod, which form the reciprocating parts, is 650 lbs. on each side. Deducting the weight that can remain unbalanced, the weight to be balanced is 400 lbs. As there are two drivers on each side, 200 lbs. of balance can be put in each wheel. If this is found to be too much, it is perfectly practicable to use six drivers for high speed; but this phase of the question can be set aside here, and the condition of the four-coupled locomotive examined as being more in accord with present practice.

"The locomotive for which these parts were designed has a 68-in. wheel, and therefore is intended for speeds up to 70 miles an hour. Larger wheels are used for higher speeds, while the cylinders and the reciprocating parts remain the same. With a 7-ft. wheel this locomotive might be expected to run at 90 miles an hour. The crank-pin velocity at 70 miles an hour, with the 68-in. wheel, is 36 ft. per second. The centrifugal force of 200 lbs., revolving at 1-foot radius, at these speeds, is 8100 lbs. for the 68-in. wheel at 70 miles an hour, and 8900 lbs. for the 84-in. wheel at 90 miles an hour. If two drivers only were used, the centrifugal forces would be about twice as much, and, if six drivers were used, the forces would be but two-thirds as much. If the locomotive is compound, the centrifugal force must be much higher. Thus the disputants have a basis to work on, and the argument can proceed without waiting for further facts so far as the locomotive is concerned. It is possible to decrease the weight of the reciprocating parts still further, but not enough so as to materially affect the figures here given.

"It now remains to be settled whether these forces will injure the track, and we shall hope that some of our readers who are trackmen will take this up. So far little of value has been published or said about the actual effect on the track of the centrifugal force of the 'excess balance' when the wheel does not lift from the rail. In this specific case the weight on the rail is about 21,000 lbs. per driver, and therefore the wheels will not lift."

The editorial having been submitted to Mr. Morrison, he makes the following replication in the same issue:

"It is undoubtedly possible to greatly reduce the effect of the excess balance in wheels, but it cannot be eliminated. A man may break his bones by tumbling out of a third-story window. He may be in the habit of tumbling out of a second-story window without breaking his bones; at the same time his bones are subject to a greater risk if he is in the habit of tumbling out of that second-story window than if he is in the habit of quietly going down the stairs. It may also be reasonably expected that his life will be shorter from such eccentric conduct, though it would be impossible to determine how much shorter it would be. It may be impossible to measure what the injury done to rails by moderate excess counterbalancing is; this does not alter the fact that they are injured and worn more rapidly than is necessary."

The debate is getting to be interesting. The outcome of it will be that the question of the effect of the locomotive upon the track will be brought nearer to settlement, and the possibility of so balancing a two-cylinder locomotive, not so that all vertical disturbance will be eliminated, but so far as to render the injury slight and tolerable, will be either determined or disproved.

Inspection of Steel-Tired Wheels.

AT the meeting of the New York Railway Club held May 16, 1895, Mr. Samuel Higgins, superintendent of motive power on the Lehigh Valley Railroad, and a member of the executive committee of the club, opened a discussion by a paper entitled: "What is the Best Way to Inspect Steel-Tired Wheels under Passenger Cars During Time Allowed at Stations?" He stated that on the Lehigh Valley Railroad there were about ten thousand such wheels, consisting of "a cast-iron center, to which the steel tire is welded." He presumed that all the members of the club would

concede the importance of such inspection, upon which the safety of high-speed passenger trains largely depends; and the first requirement for efficient inspection is to obtain good, bright inspectors. "Starting with a good, bright inspector, the next thing to be considered is: How shall this man do the work so as to get the best results during the limited time allowed for such work while trains are standing at stations? Assuming that the inspection is to be made under the most unfavorable circumstances, which I think would be after dark, is it best to provide the inspector with a good torch and a hammer for tapping the wheels?" Or, instead of a hammer, should he have a "suitable wrench for tightening up any nuts that he may find to be loose?"

From his own experience Mr. Higgins preferred the wrench, as he thought an inspector can do better work with it than with the hammer; and in his opinion the inspector ought to be instructed to inspect the inside as well as the outside faces of the wheels. He thought a careful man would detect more defects in this way than by using a hammer. He had frequently noticed inspectors tapping wheels in a most perfunctory manner, depending almost wholly on sound, and making little or no other examination.

"Several months ago one of our inspectors detected a steel-tired wheel having a defective tire, which defect was discovered by the eye and not with the hammer. The wheels were removed, and, as some of the officials of our road rather questioned the advisability of not making the hammer test, several parties were asked to take the hammer and tap the wheels as they stood mounted on the axle, not knowing which wheel was defective. Each person who tried the wheels with the hammer pronounced that the good wheel was the one with the defective tire, whereas they all thought that the wheel which had the defective tire was sound, which goes to show what chances we are taking if we depend upon the hammer test."

"Some may argue that, in addition to a close inspection by the eye of such wheels, the hammer test should be also made; but, if this is done, the inspector must dispense with carrying the wrench, and in my opinion the wrench and a good torch is a better combination than the hammer and a torch. There are many defects to which wheels are liable that the hammer test has nothing to do with, such as sharp flanges, flat spoons, etc.; which is another argument in favor of giving the wheels a close inspection with the eye rather than merely tapping them with a hammer; and, as stated before, if our inspectors are provided with hammers, they are more than liable to merely tap the wheels, and, if they sound all right, pay no further attention to them."

A lively discussion followed the reading. All who are reported as taking part in it concurred in the opinion that eyesight inspection is preferable to the sound test. In the course of the discussion it was brought out that steel-tired wheels are less liable to flat with a given braking power than cast iron, and that previous to the use of power-brakes a flat on a steel wheel was a rare thing.

Weight Per Square Inch on Car-Journals.

MR. E. W. GRIEVES has written a very interesting letter to the editor of *The Railroad Car Journal*, referring to an editorial in the March number of that publication upon the above-named subject. In this letter he states that he "recently had occasion to make some inquiries as to the practice pursued by other car builders, for the purpose of comparison; and, as the correspondence contains some information which will probably prove of interest," he sends it "for publication." Following is a copy of a circular letter he addressed to a number of heads of the mechanical departments of various railroads:

"Will you kindly advise me, for my personal information, how many pounds per square inch you calculate to carry on a car-journal? For instance, my mode of calculating this would be as follows: Take the light weight of the car, deduct the weight of the wheels and axles, add to the result the capacity of the car, and divide this by 8, to get the weight carried on each journal; and then divide that by the number of square inches in the bearing surface

of the journal, multiplying the diameter by the length. I usually, in this calculation, take the full diameter of the journal, for the reason that, if the bearing is well worn, it rides very near the center of the journal."

Answers to this inquiry are communicated as of interest to railroad men.

(1) "In figuring number of pounds per square inch on a car-journal, we use as a basis the actual bearing surface, and not the area of the journal. From inspection of the different brasses, I find that the bearing surface of a brass seldom, if ever, increases with the wear after the brass has once become fairly seated."

(2) "Our heaviest regular freight-car weighs 32,300 lbs., including trucks, and is permitted to carry a maximum lading of 66,000 lbs., of which 6000 lbs. is the permissible excess load. Our journals are 4 in. diameter by 8 in. long. We do not, however, consider it safe to take the projected area of these dimensions as the bearing surface, and as a basis on which to figure the load per square inch of a journal surface, for the reason that, when new, the actual projected area is very much less, and it is clearly the minimum projected area which is most dangerous. The projected surface on the brass is 7½ in. long by 3⅞ in. wide, giving the area, approximately, 25½ sq. in. The wheels and axles weigh very nearly 6300 lbs. The actual weight coming upon the journal is, therefore, 92,000 lbs., or 11,500 lbs. upon each journal, which, divided by the projected area of each brass, gives the maximum load per square inch of bearing surface a little less than 451 lbs. It is true that, as the brass wears, the journal imbeds itself deeper into it, but the length of the brass is diminished in the course of time by end wear, which may or may not compensate for the increased width of the bearing. Again, the journal becomes reduced in diameter, and in the later stages of its existence, before it is removed, it may be down to very nearly 3¾ in., and the brass may again be worn to a considerable amount at the ends. The safe measurement is, therefore, I think, that obtained from measuring the projection of the surfaces in contact when the brass and axle are new."

(3) "The weight of our heaviest cars, when loaded to their full capacity, which are our 60,000-lb. capacity furniture cars, is 335 lbs. to the square inch on the axle. Our 60,000-lb. capacity box-cars carry 320 lbs. to the square inch. We arrived at the weight in the same manner that you do. We are having very little trouble with these cars."

(4) "The maximum load on our car-journal is, with our 30-ton loaded car, when we have 90,000 lbs. on eight journals, each having a bearing surface of $7\ 5/8 \times 4 = 30$ sq. in.

$\therefore \frac{90{,}000}{8 \times 30} = 375$ lbs. per sq. in. We think 4 in. wide is ample to count on, as but little pressure comes on the side when the bearing is badly worn. The full weight of the car and load should be taken, as the bearing is seldom on the whole surface, and the reduction of weight of wheels and axles is small compared with the increase in pressure per square inch due to the reduced bearing surface under which bearings are liable to run. With the full load and full surface, however, the pressure per square inch on freight-cars is 375 lbs., as given above. If the brass had a bearing on but half of its proper surface, the pressure per square inch would be 750 lbs. Our mechanical engineer says: 'With 33-in. wheels and at 60 miles per hour, the speed is six hundred revolutions per minute; four hundred for 40 miles per hour,—a high average for freight-cars. In tests of bronze bearings at speeds of 500 revolutions per minute, the temperature increases rapidly when the pressure exceeds 450 lbs. per square inch.' He is of the opinion that 400 lbs. is the maximum which should ever be reached, and we concur with him in this opinion."

(5) "I have never made any previous calculations in regard to the weight per square inch of sectional area of journals that we are carrying on our cars. If I were going to figure it, I should do it in the same manner that you have stated. I find that the severest load per square inch

on that basis that we are carrying is in our 50,000 lbs. capacity drop-bottom coal-cars, which have 3¼ × 7 in. journals; these are carrying a load of 342 lbs. per square inch of sectional area. The heaviest load per square inch that we have with 4¼ × 8 in. journals is in our 40-ft. furniture cars, which have a load of 306 lbs. per square inch. In the case of the drop bottom coal cars, would say that we have box-cars weighing a little more than the coal-cars, which had the same rating—50,000 lbs. capacity—and had the same—3¼ × 7-in.—journals. I found we had so many journals burned off on these cars that it was necessary to lower the rating to 45,000 lbs., and recommended having the same change made on the coal-cars, but it was not approved by the general manager. Of course, in actual service, where a new journal bearing is applied to a journal, the entire weight is distributed in a strip not over 1 in. wide the entire length of the journal. As the brass wears down, the size of the bearing surface increases, but, when it first commences, there must be something like 1200 lbs. to the square inch on the bearing surface."

(6) "I think it difficult to say just how much we carry on each journal, because a car marked for 60,000 lbs. may and does have sometimes much more on it. I saw a car only a few days ago that had journals only 3¼ × 7 in. That was weighed with the load, and its weight was 123,000 lbs. The car weight light was about 23,000 lbs., having 100,000 lbs. for a load on a smaller journal than we use for 60,000 lbs. load; but, as to the manner of getting at the weight per square inch, you are right, except I do not think you should take the full diameter of the journal; while I admit, if the bearing is worn, it will cover about one-half of the journal, or extend down to the center; but the weight, I conclude, is only on about one-third of the journal. So I take our own thus: weight of wheels and axles, about 6400 lbs., leaves on journal 20,600 + 60,000 = 80,600 lbs. on the eight journals; on one, 10,075 lbs. I think our brasses, 4½ × 7½ in., have not far from 26 in. bearing surface, which would bring about 388 lbs. per square inch. This is what I calculate is on ours when loaded with 60,000 lbs."

Some of the replies show a distrust of projected area of journals as a basis for computing weight permissible on axle-bearings; and it may be that for bearings in other kinds of machinery this basis is misleading. From the data thus supplied Mr. Grieves has compiled a table which accompanies his letter in *The Railroad Car Journal*, and which may probably be relied upon as representing average American practice.

THE RAILROAD GAZETTE says, speaking of a letter from the Interstate Commerce Commission warning railroad officers not to assume that illegal contracts become legal by being filed with the commission, attributes it to the fact that the Central Traffic Association neglected to reply to a request for a copy of an eastbound freight contract. Commissioner Blanchard sent to Washington the proceedings of the meeting of April 9, in which the roads voted that "the Commissioners of the Central Traffic Association have power to even up the Chicago roads that are deficient in their tonnage by withdrawing the roads that are over from soliciting in the market, and by the transfer of freight to the deficient roads when practicable, the lines in deficit to receive and forward the said tonnage." This implied some agreement as to what basis the tonnage should be evened up to, and the Commission asked for a copy of this agreement, but it was not forthcoming. The working of this interstate commerce law appears to be developing far too much friction for a well-designed machine.

Street Railway Statistics.

THE table on the next page which we reproduce from *The Street Railway Journal* for July is claimed by the editors of that enterprising publication to be the most complete, as relates to mileage, cars, and capitalization, that has yet appeared Commenting editorially upon it, they assert their belief that the mileage may be considered accurate within 5 per cent. for all States except Pennsylvania; and that

STREET RAILWAY STATISTICS OF THE UNITED STATES.

TABLE I.—MILEAGE, CARS, CAPITAL STOCK AND FUNDED DEBT.

STATES.	No. of Roads.	MILES OF TRACK.					NO. OF CARS.		CAPITAL STOCK.		FUNDED DEBT.		CAPITAL LIABILITIES.	
		Horse.	Electric.	Cable.	Miscel.	Total.	Total.	Per Mile Track.	Total.	Per Mile Track.	Total.	Per Mile Track.	Total	Per Mile Track.
New England.														
Maine	11	25	63			91	198	2.16	1,889,925	20,600	1,546,000	16,900	3,435,925	37,500
New Hampshire	5	27	27			54	121	2.28	475,000	8,900	360,000	6,800	835,000	15,700
Vermont	2		14			14	31	2.15	285,000	19,800	195,000	13,500	480,000	33,300
Massachusetts	54	77	892			969	3,896	4 02	31,611,375	32,000	23,020,000	23,700	54,631,375	56,300
Rhode Island	9	3	155			158	520	3.29	11,604,500	73,400	11,608,000	73,400	23,212,500	146,800
Connecticut	23	33	241			274	753	2.75	7,912,500	28,800	6,817,000	24,900	14,729,500	53,700
TOTAL	104	165	1,392			1,560	5,519	3 54	53,778,300	34,500	43,546,000	27,900	97,324,300	62,400
Eastern States.														
New York	98	352	1,020	46	164	1,583	9,415	5.76	176,176,723	111,200	153,131,445	96,700	329,308,168	207,100
New Jersey	30	53	418		2	473	826	1.75	31,908,750	67,600	29,180,500	61,800	61,098,250	129,400
Pennsylvania	124	48	1,304	92	8	1,422	4,021	2.82	116,293,850	81,700	42,307,560	29,700	158,601,410	111,500
Delaware	3		26			26	64	2.49	358,000	13,900	600,000	23,300	958,000	37,200
District of Columbia	11	63	52	28		143	927	6.49	4,615,500	32,300	7,220,000	50,600	11,835,500	82,900
Maryland	11	24	205	21	2	252	668	2.66	12,845,000	51,100	12,967,000	51,600	25,812,000	102,600
Virginia	16	16	134		4	154	290	1.89	4,060,250	30,400	3,221,000	21,000	7,877,250	51,400
West Virginia	6	10	30		9	49	90	1.88	1,340,000	27,000	682,000	14,200	2,022,000	42,100
TOTAL	305	567	3,189	187	189	4,102	16,001	3.90	348,194,073	84,900	249,318,505	60,800	597,512,578	145,700
Central States.														
Michigan	30	60	272		9	341	1,000	2.95	6,581,200	19,300	8,089,000	23,700	14,670,200	43,100
Ohio	63	58	972	43	4	1,077	3,254	3.02	51,942,250	48,200	22,334,590	20,700	74,276,750	68,900
Indiana	29	25	297		8	330	755	2.29	9,363,550	28,400	7,470,000	22,600	16,833,550	51,000
Kentucky	11	59	147			206	625	3.03	7,496,900	36,400	6,530,000	31,700	14,026,900	68,100
Wisconsin	18	20	240		12	281	472	1.68	7,720,000	27,400	13,187,000	46,900	20,907,000	74,300
Illinois	43	267	529	86	69	951	5,815	6 12	66,213,025	69,600	55,918,000	58,800	122,131,025	128,500
Minnesota	14	11	516	13		540	1,095	3.69	29,274,000	54,200	26,863,000	49,700	56,137,000	103,900
Iowa	23	18	210	7	8	243	401	1.90	8,216,100	33,800	4,806,000	19,800	13,022,100	53,600
Missouri	30	37	386	103	24	550	2,555	4.64	35,834,000	65,100	28,370,000	51,600	64,204,000	116,700
TOTAL	275	555	3,573	252	134	4,519	16,030	3 74	222,641,025	49,300	173,567,590	38,400	396,208,525	87,700
Southern States.														
North Carolina	11	4	37		4	45	81	1.82	911,700	20,500	855,000	19,200	1,766,700	39,600
South Carolina	6	36	10			46	103	2.25	462,000	10,100	296,000	6,500	758,000	16,600
Georgia	19	21	246		14	281	402	1.42	4,931,000	17,500	5,085,500	18,100	10,016,500	35,600
Florida	7	24	11			35	124	3 57	362,500	10,400	4,600	100	367,100	10,500
Alabama	20	27	79		126	223	311	1.40	5,809,800	26,100	2,650,000	11,900	8,459,800	38,100
Mississippi	6	21			2	23	60	2.67	215,000	9,600	16,500	700	231,500	10,300
Tennessee	23	16	178	6	67	267	479	1.77	6,262,000	23,500	4,854,600	18,200	11,116,000	41,600
Louisiana	12	36	159			195	226	1.16	13,286,350	68,100	8,838,000	45,300	22,124,350	113,400
Arkansas	7	29	32			61	150	2.46	915,375	15,000	978,700	16,100	1,894,075	31,100
TOTAL	111	214	743	6	213	1,176	1,930	1 64	33,155,725	28,200	23,578,900	20,100	56,734,625	48,300
Western States.														
South Dakota	6	17	11		7	35	21	.60	350,000	10,000	75,000	2,100	425,000	12,100
Nebraska	13	49	169			218	464	2.12	8,652,500	39,700	3,760,000	17,200	12,412,500	56,900
Kansas	12	30	83		11	130	185	1.43	3,720,000	28,700	2,786,000	21,500	6,505,000	50,200
Texas	40	81	242		24	347	531	1.53	6,759,001	19,460	5,421,000	15,600	12,180,001	35,100
Colorado	11	8	205	30	15	261	638	2.44	9,920,000	38,000	10,130,000	38,800	20,050,000	76,800
Montana	4		52	2	2	56	69	1.25	1,700,000	30,800	1,250,000	22,700	2,950,000	53,500
Idaho	1		3			3	2	.67	53,300	17,800			53,300	17,800
Utah	4		90		6	96	120	1.25	1,800,000	18,800	1,400,000	14,600	3,200,000	33,400
Washington	23	7	187	18	4	216	244	1.13	9,862,000	45,700	5,414,000	25,100	15,276,000	70,800
Oregon	12	7	99	7	24	137	218	1.60	2,451,000	18,000	2,735,000	20,100	5,186,000	38,100
California	32	205	317	100	50	732	1,887	2.57	44,977,282	61,400	29,144,000	39,800	74,121,282	101,100
TOTAL	178	410	1,461	217	143	2,231	4,359	1.95	90,245,083	40,300	62,114,600	27,700	152,359,683	68,000
United States.	976	1,914	10,363	632	679	13,588	44,745	3.29	748,014,206	55,000	552,125,595	40,600	1,300,139,711	95,600
Canada.	32	43	389			432	1,011	2.34	14,317,800	33,200	4,475,000	10,400	187,92,800	43,500

even in that State, wherein extensions and new constructions are very active, the error will fall within 10 per cent. The capitalization is also thought to be correct within 10 per cent., and in most of the States within 5 per cent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*32400. The Trolley in Competition with Railroads.—An Interesting Situation in Connecticut. Clarence Deming (Eng Mag–Aug.) 4000 w.

32437. Conduit Railways. Ill. Max J. Levy (Elec Age–June 8.) 1800 w.

32440. Electric Railways and Tramways in Great Britain. Albert H. Bridge (St R'y Gaz–June 8.) 1000 w.

32444. The Need of Uniformity in Car Construction. Editorial (R'y Mas Mech–June.) 800 w.

32445. The Discipline of Employés. (Extract) William Gibson (R'y Mas Mech–June.) 1600 w.

32446. The Locomotive Testing Plant of the Chicago and Northwestern Railway. Ill. (R'y Mas Mech–June.) 1400 w.

32447. A Simple and Short Method of Producing Power Diagrams. Theodore H. Curtis (R'y Mas Mech–June.) 2200 w.

32452. Railway Enterprise in Egypt. Frederic C. Penfield (Elec Rev–June 12.) 450 w.

32453. Car Service. Report of Committee of the Am. R'y Asso., with Editorial (R'y Rev–June 8.) 3000 w.

*32471. The Crampton Locomotive. Ill. W. B. Paley (*R'y Wld*–June.) 1600 w.

*32472. The First Inside Cylinder Locomotive. G. A. Sekon (*R'y Wld*–June.) 1800 w.

†32493. The Railroad in Asia. Charles Morris (New Sci Rev–Jan.) 6000 w.

†32501. Railroad Facts and Figures. Melville Phillips (New Sci Rev–April.) 2700 w.

32511. Trolleyizing the Nantasket Beach Railroad. Ill. (R R Gaz–June 14.) 1800 w.

32512. Pooling Locomotives. F. R. Foster (R R Gaz–June 14.) 2200 w.

32513. Separation of Grades on the N. Y., N. H. & H. R. R. in Boston. Ill. (R R Gaz–June 14) 2000 w.

32514. English Block Signal Rules. (R R Gaz–June 14.) 1700 w.

32515. Classification of Passenger Traffic in England. C. H. Grinling (R R Gaz–June 14.) 2500 w.

32516. An Important Mexican Railroad Contract—The Tehuantepec Railroad (Mfr Rec–June 14.) 900 w.

32531. Tank Locomotives and the Brooklyn Bridge. Ill. (Eng News–June 13.) 600 w.

32535. American and French Four-Cylinder Compound Freight Locomotives. Ill. (Eng News–June 13) 1100 w.

*32567. Brakes for Light Railways—From Report of M. Plocq (*Engng*–June 7.) 3800 w.

*32584. The Effect of Negative Lead on Locomotives. Ill. (*Mech Wld*–June 7.) 1600 w.

32615. Reports of Committees at the Master Car Builders' Convention, with Editorial. (Ry Rev–June 15.) 10700 w.

32656. Electricity or Steam? H. G. Prout, in New York Independent (Elec Eng–June 19.) 3500 w.

*32661. The Inter-Continental Railway. Ill. Dion Martinez (Stone–June.) 1300 w.

*32665. Price Hill at Cincinnati. Ill. (St R'y Rev–June.) 700 w.

*32666. The Inter-Urban Electric Railway. (Abstract.) Ill S. H. Short (St R'y Rev–June.) 2500 w.

*32667. A Model Inter-Urban Car. Ill. W. E. Haycox (St R'y Rev–June.) 600 w.

32683. A Great Railroad Move.—Southern Railway Co. to Go into Norfolk. D. Allen Willey (Mfrs Rec–June 21.) 1600 w.

32684. The Tehuantepec Railroad. A Great Opportunity for American Contractors (Mfrs Rec–June 21.) 1800 w.

32690. The Master Car Builders' Laboratory Tests of Brake Shoes (Eng News–June 20.) 2200 w.

32694. The Chicago Plan of Interchange at the M. C. B. Convention. Editorial (Eng News–June 20.) 2400 w.

32696. Belt Line Power Station and Equipment. Ill. Louis Duncan (Elec Age–June 22.) 1000 w.

32698. Trolley Currents and Automatic Signals. G. N. Thayer (Elec Age–June 22.) 700 w.

*32708. Workmen's Trains. Editorial (*Engng*–June 14.) 2200 w.

(*32720. The Gare de Sceaux Central Station. Ill. Emile Dieudonné (*Elect'n*–June 14.) 2600 w.

32741. Accumulators on Electric Railroads. Ill. (West Elec–June 22.) 1200 w.

32776. Bridges for Elevation of Tracks on Chicago, Rock Island & Pacific, and Lake Shore and Michigan Southern Railways in Chicago. Ill. (Ry Rev–June 22.) 1700 w.

32777. Safe Speed of Trains at Interlocked Grade Crossings. W. J. Gillingham, Jr. (Ry Rev–June 22.) 1000 w.

32779. What Is the Best Way to Inspect Steel-Tired Wheels Under Passenger Cars During Time Allowed at Stations. Mr. Higgins, with Discussion. Paper read at N. Y. Railroad Club. 2800 w.

32807. The Boston Electric Railway Subway. Ill. (Sci Am Sup–June 29.) 900 w.

32817. Why the Free Time in New England

We supply copies of these articles. See introductory.

Is Ninety-six Hours. E. A. Gordon (R R Gaz-June 28.) 700 w.

*32825. The Relation of Railroad Transportation to Production in California. R. L. Dunn, with Discussion (Jour As Eng Soc-May.) 10000 w.

*32827. The Abolition of Grade Crossings Between Railroads and Highways. I. The Gradual Abolition of Highway Grade Crossings. Augustus W. Locke II. Abolition of Grade Crossings. James W. Rollins, Jr. III. Abolition of Grade Crossings in the City of Brockton. a. F. Herbert Snow. b. James W. Rollins, Jr. (Jour As Eng Soc-May.) 11500 w.

*32828. Abolition of Grade Crossings on the Providence Division of the Old Colony Railroad in Boston. James W. Rollins, Jr., with Discussion (Jour As Eng Soc-May.) 5500 w.

32852. Electric Railway Lines of the Chicago City Railway Company. Ill. Abstract from Chicago Sunday Tribune (W Elec-June 29.) 2000 w.

*32882. The Railway Congress (*Eng*-June 21.) 6200 w.

*32922. The Working of Belgian Vicinal Railways. Anon. (*Jour Soc of Arts*-June 21) 1900 w.

†32954. A Cause and Remedy for Sharp Flanges. Ill. C. F. Ubelacker (St Ry Jour-July.) 600 w.

†32956. Can Electricity Compete with Steam. Editorial (St Ry Jour-July.) 1800 w.

†32957. The Electric Locomotives of the Baltimore and Ohio Railroad (St Ry Jour-July.) 4800 w.

†32958. Electric Car Trucks. Ill. William Robinson (St Ry Jour-July.) 1800 w.

†32959. Street Railway Statistics of the United States (St Ry Jour-July.) Table.

32969. Discipline. W. M. Duane (Ry Rev-June 29.) 500 w.

32982. Elevated Railroads in Chicago. Editorial (Ry Age-June 28.) 1100 w.

†32985. Railway Extension in India. H. (*Ind Engng*-June 1.) 800 w.

*32989. The International Railway Congress. Editorial (*Trans*-June 28.) 2500 w.

*32992. Economy of Locomotive Working and Maintenance. R. Price-Williams (*Eng Rev*-June 20.) 2200 w.

*32993. Development of the Crewe System of Compounding Locomotives. Ill. F. W. Webb (*Eng Rev*-June 20.) 1000 w.

*32994. English Wagons and American Bogie Trucks. John A. F. Aspinall (*Eng Rev*-June 20.) 1000 w.

*32995. The Influence of Patent Law on Railway Progress. W. Lloyd Wise (*Eng Rev*-June 20.) 2500 w.

*32996. The Development of the Locomotive. Ill. (*Eng Rev*-June 20.) 500 w.

*32997. Railway Brakes. Lucien Serraillier (*Eng Rev*-June 20.) 2500 w.

*32998. The Railway Rate Problem (*Eng Rev*-June 20.) 1300 w.

*32999. Electric Locomotives and Railways. Ill. (*Eng Rev*-June 20.) 3000 w.

*33000. On the Recent Progress of Permanent Way (*Eng Rev*-June 20.) 3800 w.

*33001. The Trans-Siberian Railway (*Eng Rev*-June 20.) 1600 w.

*33003. Great Mountain Railways. John Harrison Means and John C. Branner (Chau-July.) 6000 w.

*33036. Indian Railway Development. Editorial (*Engng*-June 28.) 1600 w.

*33044. Speed Regulation of Electric Motor Cars. Philip Dawson (*Elec Rev*-June 28.) 800 w.

Serials.

24586. Railway Companies and Their Employes. O. D. Ashley (Ry Age-Began Aug 24, 1894—13 parts to date—15 cts. each).

24741. Special Shop Tools. Ill. (Ry Mas Mech-Began Sept., 1894—3 parts to date—15 cts. each).

25670. Painting a Railway Passenger Car. A. Ashmun Kelly (Ry Mas Mech-Began Oct., 1894—6 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliott (Loc Engng-Began Jan.—7 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*-Began Jan. 4—22 parts to date—30 cts. each).

29369. Tramway Management. By a Manager (*Ry Wld*-Began Feb.—5 parts to date—30 cts. each).

29840. Travels of the World's Transportation Commission. Clement F. Street (Ry Rev-Began March 2—3 parts to date—15 cts. each).

30604 Locomotive Repair Shop Equipment. W. H. Weston (Nat Car & Loc Build-Began April—4 parts to date—30 cts. each).

30654. Street Railway Repair Shops. Ill. Henry P. Merriam (St Ry Jour-Began April—4 parts to date—45 cts. each).

31738. Compressed Air Motors for Tramway Traction. Ill. H. Conradi (*Ry Wld*-Began May—2 parts to date—30 cts each).

32562. Belgian Railways (*Engng*-Began June 7—1 part to date—30 cts).

32663. Vestibule Equipment. Ill. (St Ry Rev-Began June—1 part to date—30 cts).

32711. Express Locomotives. John A. F. Aspinall (*Eng*-Began June 14—Ended June 28—3 parts—30 cts. each).

32749. Effect of Temperature on the Strength of Railway Axles. Ill. Thomas Andrews (*Ind & Ir*-Began June 14—1 part to date—30 cts).

33002. The Past and Future of Railway Construction in the United States. Edward Atkinson (*Eng Rev*-Began June 20—1 part to date—30 cts).

33056. A Method of Electric Traction for Tramways in Towns.—The Thwaite-Cawley System (*Elec Eng*-Began June 28—1 part to date—30 cts).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Pitch Lake of Trinidad.

MR. S. F. PECKHAM, in *American Journal of Science* for July, gives a very interesting description of this remarkable deposit. He finds that previous descriptions of it given 40 to 100 years ago are in the main correct, so far as they extend. The pitch in this lake, though apparently solid, is in reality in a state of very slow ebullition. Mr. N. S. Manross, writing of it in 1855, says: "As the descent of the glacier may be considered the slowest instance of flowing in nature, so the revolutions of the scarcely less solid bitumen of this lake may be set down as the slowest example of ebullition."

In 1892, Hon. W. P. Pierce, United States consul at Port of Spain, made a very full and able report upon the asphalt of Trinidad, this report having been followed by another by Mr. Clifford Richardson, at that time inspector of asphalt and cement for the District of Columbia. The latter differed materially from that of Mr. Pierce in statements and conclusions, and Mr. Peckham explains that it was for the purpose of satisfying himself as to the facts that he visited the lake. The following is an abstract of Mr. Peckham's paper.

On approaching Point La Brea from the northwest, the reef of asphaltum that forms a barrier around the point and against the sea is plainly visible. Upon the point itself, and jutting into the sea, are what appear like low ledges of rock, which a nearer inspection proved to be masses of asphalt taken from village lots that had been piled for shipment, but had been so long left in the tropical sun that they had melted and flowed into a solid homogeneous mass looking at a short distance, like ledges of slate. The piles, which were originally about 25 ft. in height, were not more than 3 ft. thick. Near these masses were other piles of the same material, from which lighters were being loaded, and which had not remained in the sun long enough to melt. Many hundreds of tons were included in these masses, the original pieces of which had so far coalesced that the asphalt had to be again broken with a pick before removal.

"Passing on shore and beyond these piles, the plant of the pitch lake *concessionaires* was encountered, in which the operation of boiling a mixture of so-called land asphalt, the ordinary lake asphalt, and the soft pitch from the center of the lake was going forward. The operation is conducted in kettles, resembling open sugar kettles, and is a very crude and simple operation. Passing eastward, I next encountered a wide area covered with asphalt that had melted in the sun to a level surface perhaps 2 ft. in depth. I was told that this asphalt was dug from a village lot, the ownership of which was in dispute; that originally the piles were at least 20 ft. in height, but, while the owners disputed, the piles melted in the sun.

"Farther on I struck the road to the lake, which appeared to me exactly as Mr. Manross had described it 40 years ago. The houses in the village were in the same condition described by Dr. Nugent in 1807. The slope leading up to the lake was in exactly the condition in which all previous observers had described it, as resembling a lava flow—a black glacier. The several points at which asphalt had been and was being excavated showed in the most admirable manner that the movement of the asphalt down the slope and towards the sea is still in progress. Every excavation was in a short time partially refilled by a movement of the asphalt up from the bottom and in from the sides, the cavity in time becoming filled full to the level of the surrounding area. One illustration of this fact was the spot from which the noted cargo of the Teneriffe was taken, every trace of former excavation having completely disappeared.*

*"I was told by those who witnessed the digging of this cargo that apparently no care was exercised in its selection. One gentleman declared that it was the dirtiest cargo of pitch ever sent from the island."

"The Trinidad Bituminous Asphalt Company were excavating a lot near the road, and had also recently uncovered a lot that had become almost completely refilled in a few months, after the removal of several thousand tons of asphalt. Farther up the slope the Trinidad Asphalt Company were taking out asphalt from lots on the Belle Vue estate. These lots, like most of the others, were covered with a dense tropical jungle, consisting of palms, sedges, canna, and other plants, from 3 to 10 ft. in height. It did not need the testimony of Mr. Manross to show that, in all probability, fire had more than once consumed this mass of vegetation, producing a terrific heat that had melted and converted into so-called 'iron pitch' much of the surface of the pitch. The 'iron-pitch' is present in greater or less quantity, both within and without the boundaries of the lake, wherever fire has consumed the vegetation, and consists simply of melted pitch which has been heated so hot as to deprive it of its water and more volatile constituents, causing it to flow in streams, often to considerable distances. Below these melted masses the pitch lies in its normal and unaltered condition.

"It must, however, be constantly borne in mind, while reading the statements of different observers made on different occasions, that the lake and its principal overflow have presented different phenomena at different periods. While it was evident at the time I visited the overflow that fire had swept over the surface, it was equally evident that it had for a long time been free from any such visitation. I have seen similar flood-plains of asphalt in California that had been on fire for months, and others that had been burned some time previous to my visit to them. I can imagine that, after such a fire, the resemblance of the overflow of the lake to a 'black glacier' would be much more pronounced than when covered with a rank growth of vegetation, as it now is. It is not, however, the surface that flows, covered, as it is, by masses of coke, iron-pitch, vegetation, and rubbish. The houses in La Brea now all rest on blocks. In this position they are much more stable than on posts, although anything resting upon the overflow is unstable. It is the cheese-pitch, full of water and containing more or less gas, buried beneath these surface accidents, that has flowed and still flows.

"Although a large amount of clay and vegetable *débris* fills the interstitial spaces of the rough surface of the asphalt, the vegetation is not confined to such surfaces, but seems to flourish equally well upon the bare pitch, the roots penetrating the pitch without the slightest difficulty, except where it had been converted by melting into iron-pitch. There is also considerable coke where the fires have been hottest. All of these impurities are carefully excluded from the pitch that is mined, both for boiling and for shipment in the crude state, by all of the men employed by the different companies in extracting it. This selection is not difficult, as the appearance of the iron-pitch is very different, and the amount very small, as compared with the pure or cheese-pitch."

The appearance of the lake closely resembles that of the asphalt beds in California. Mr. Peckham thinks that the suggestion made by Mr. Richardson that "the lake occupies the crater of an old mud volcano is correct, and that it is built up of very unstable material, through contact of water issuing in large quantity from subterranean springs," carrying with it large quantities of disintegrated rock, so that the stream resembled a stream of quick sand. Into this stream the bitumen was projected, "at intervals in very large amounts, so that irruptions of mud have coincided with and alternated with irruptions of bitumen, the whole building up the cone and at times overflowing it, while the basin gradually filled with bitumen to the exclusion of mud."

Technical Research.

AN editorial in *Engineering* (June 28) is a strong plea for the promotion of original research by engineering associations and scientific societies, since want of means generally makes it impracticable for individuals most competent to make such researches on their own account to do so, except in certain lines of patented or pat-

entable inventions. Engineers in general are engaged in original research; but it is mostly "at the expense of their clients."

"Great advances in engineering practice wait more often upon details than upon principles. The conception of the compound marine engine is old enough, but it was not until a satisfactory surface condenser was produced that it became commercially possible. As long as the boiler was fed direct from the sea, 30 lbs. per square inch was the limit of practicable pressure, and compounding offered no advantage under this condition. The surface condenser, as now made, is a simple enough affair; yet it took many years to arrive at it, because neither marine engineers nor ship owners were willing to spend the necessary money over a series of comparative experiments. Occasionally a sanguine individual ventured to try one, and, when he found it unsatisfactory, he generally preferred to face the known loss of abandoning it rather than enter into a series of experiments to perfect it. The triple-expansion marine engine furnishes another example. Up to about 1881 there was scarcely an engine of this kind constructed, and after that date there were very few built of any other kind. The deterrent cause in this case was a misgiving as to the possibility of finding a satisfactory material for boilers carrying 160 lbs. to 180 lbs. pressure, and complying with the requirements of marine service. Ship-owners held back from making experiments for the benefit of the trade. For years they stuck to the compound engine, well knowing that a 20 per cent. economy was available, if only certain preliminary difficulties, by no means insuperable, could be overcome. But, naturally, no one was willing to pay for experience that would be immediately public property."

Allusion is made to unsuccessful attempts in the past to develop processes, or find practical uses for materials. These attempts progressed far enough to become a bar to the procurement of valuable patents, but not far enough to render them available. Now their further prosecution must either be at the expense of individuals who cannot expect return for the expense incurred, or at the expense of associations willing to create and devote funds for experimental work.

"Superheating furnishes a case in point. It is generally believed that we are on the verge of a revival of superheating, and that it will be successful. But in years past there was a very determined attempt to use superheated steam. Apparatus was fitted in a large number of instances, particularly on board ship, and, after extended trial, was abandoned for several reasons. First and foremost, there was the difficulty of finding a lubricant that would not decompose under the influence of very hot steam. The introduction of mineral oils and vaseline has removed that source of failure without any effort on the part of mechanics. Then there was the chance of the superheater becoming incrusted with salt carried over from the boiler with priming water. But salt in boilers is, or should be, a thing of the past, now that evaporators are so common, and thus a second source of failure has disappeared. The other difficulties were chiefly mechanical, and individually were not serious. But, taken in the aggregate, they are fairly formidable, and it is certain that they will take some time and a liberal expenditure of money to entirely overcome. As our columns have shown, attempts are now being made on a practical scale to introduce superheating. The attitude of the profession is one of expectancy; the majority are waiting to appropriate the result of other people's experiments, certain that nothing can be discovered that will furnish grounds for anything but a narrow patent."

Although professors in colleges find it to their interest to perform experimental work without a direct reward, and the debt which the engineering profession owes to such investigators is freely acknowledged, the limitations of "the powers of the technical laboratory" are pointed out. "Full-sized experiments are beyond its scope. If no other consideration intervenes, there is always expense to be considered. In spite of the constantly-rising fees charged for tuition, educational establishments share

in a marked degree in that 'eternal want of pence' that troubles the greater part of humanity. The available funds have to be spread over the largest possible area, like boarding-school butter. Investigations on a really large scale can, therefore, not be attempted. There is very little chance of getting these done elsewhere in a systematic manner, if, as we have already pointed out, the results cannot be secured to the experimenter under the patent laws. One notable exception, however, is found in this country [England] to this rule. We refer to the researches undertaken by the Institution of Mechanical Engineers. On these there have been spent hundreds—possibly thousands—of pounds, and the results have been freely given to the world. The researches made by the Institution on riveting, on friction, on steam-engine economy, and on alloys, are splendid monuments of the large-mindedness of the council. We know that certain continental societies have carried out similar inquiries, but not, we believe, with the same completeness."

The American Society of Mechanical Engineers ought, in justice, to have been named in this connection. Though a young society, it has been doing noteworthy and praiseworthy work in original investigation, the evidence of which is abundant in the reports and papers presented at the recent Detroit meeting. There are other young societies that ought to have been included. Among these is the Canadian Society of Civil Engineers, which has been encouraging and doing some good experimental work. Without naming others that could well be mentioned, we incline to the belief that engineering societies, as a rule, are not as apathetic as regards original investigation as one might infer from the editorial reviewed. Nevertheless the article is timely and presents the subject in the proper light. Henceforth the bulk of this sort of work must be done by such societies, or go undone.

A Standard of Sound.

ENGINEERING (June 14) prints a letter by Mr. Hiram S. Maxim, the famous inventor and aeronaut, which contains a novel suggestion,—to wit, that a standard unit of sound shall be adopted by the scientific world. The author thinks that "some clever experimenter, like Professor Crookes or Professor Boys, should take the matter in hand, and establish a convenient unit of sound which would be accepted by the royal society of Great Britain and the board of trade." If such a unit should be established and accepted by the two bodies named, Mr. Maxim thinks it would also be acceptable in law courts as a means of deciding many vexed questions.

"All owners of electrical plant are liable to be complained of for making a noise. Sometimes it is said that their machinery causes vibrations to the surrounding buildings or ground; then, again, that they disturb telephonic communications. Manufacturers are constantly having injunctions served on them for making too much noise, when, perhaps, as a matter of fact, the noise is not even audible to those who make the complaint. In many cases, when electrical engineers and those interested in electrical plants have visited the houses of parties who have lodged complaints against electric-light stations, it has often been found that parties making these complaints were themselves willing to swear and were ready to bring any number of witnesses to prove that the noise and jar produced were enough to drive them nearly mad, when, as a matter of fact, the jar and noise were wholly occasioned by the ordinary street traffic, and, at the very moment when they pretended to be so much annoyed, the electric-light plants have not been running at all. Owners of electric and other plants may be, and often are, served with injunctions restraining them from running their works, when, in fact, the noise complained of is less than that produced by one cab passing along the street."

Mr. Maxim gives some amusing instances illustrating this tendency of people to lodge groundless complaints. The Maxim guns are fired at Erith in a building specially designed to suppress the noise and jar; nevertheless formal complaints have been made against the firing, and on the very day when no Maxim guns

were fired at all. The real noise came from Plumsted Marshes about 5 miles away, where the government have always fired their large guns, and cannot now be restrained from doing so. Another instance is cited of a large manufactory, also at Erith, which, "having a small quantity of riveting to do, went to great expense to cover everything with felt, so that no noise could escape." The neighbors, however, imagined that they heard noise, and lodged numerous complaints applying for injunctions to restrain the establishment from carrying on its business. Mr. Maxim says that the real noise issuing from the factory is not greater than that produced by "a rubber-tired bicycle."

Now, when these complaints come into court, the evidence upon which they are determined is merely that of opinion,—expert and otherwise. As a result much injustice is done. Mr. Maxim goes on to suggest lines of experiment which may lead to a satisfactory selection of a phonic unit. "I would suggest, as a starter, that a kind of phonograph should be employed, and that the record should be made on smoked glass, which could be put in a magic lantern and greatly enlarged. The amplitude and frequency of the waves would indicate the intensity of the noise produced. For example, suppose a certain record should be made of the noise of the ordinary street traffic, and then another record of the noise of both the street traffic and the disturbance or noise complained of,—the two mounted side by side and projected on a large screen would enable the judge to see at a glance how much the noise was increased by the machinery, and how much cause there was for complaint. As a standard of noise which might be shown in court, I would suggest that shot of a certain size should be dropped, say, from a height of 1 meter, onto some standardized diaphragm, and that the waves should be recorded at, say, 5 meters from the diaphragm. A record of this artificial noise could be also shown on the screen, and at the same time the actual noise recorded produced in court. For telephones a record of the vibrations set up while the machines were running should be compared with one of those set up when the machines were not running. The comparison of the two would enable the judge—or the jury—to see exactly what the increase in noise actually was." In conclusion, Mr. Maxim intimates that his purpose has been merely to suggest that a phonic unit is needed, and to show that the suggestion can be carried out.

"Honor to Whom Honor is Due."

MANY newspapers have recently noticed the action of the University of Wisconsin in conferring the honorary degree of LL.D. upon each of the well-known and justly-celebrated engineers, Mr. Edwin R. Reynolds of Milwaukee, Wis., the designer and builder of the Reynolds Corliss engine, and Mr. Don J. Whittemore of Milwaukee, Wis., chief engineer of the Chicago, Milwaukee & St. Paul Railway. Both these men have achieved national reputation in their respective fields of engineering, and both have well merited the honor conferred.

In commenting upon this action of the university, the papers announcing it have mostly missed its true significance. The action means that no longer, as heretofore, are institutions of learning going to confine their honors to those who have achieved eminence in the so-called learned professions, in statesmanship, in science, and in literary work. It means an extension of the application of the word "*learned*" to the engineering profession in all its departments,—the recognition of the fact that in any of these branches eminent achievement implies superior acquirements and superior ability (whether attained in the schools or out of them), as much as, or more than, in law, medicine, or theology, and that the old convention which has hitherto restricted the application of this term to the professions named is melting away in the broader intellectual horizon over which is dawning the morning of the twentieth century.

We believe the time is coming when the engineering profession will take rank with, if not precedence of, the professions which from medieval times have been considered most honorable; and we regard the signs

of this tendency as the most hopeful of indications. The period in which this recognition will be fully achieved will, however, be hastened or retarded by the action of engineers and their associations. These should now press their claims to such recognition. It is easy to show that engineering requires of its adepts an amount of learning and preparation, as well as a natural fitness, in no wise inferior to those possessed by the most shining lights in other professions. Though the preparation is of a different nature, its effect upon the general culture of the man who pursues the course of study comprised in it is as potent as that of the classical course hitherto supposed necessary to the development of the finer qualities of mind and character.

The Production and Uses of Cotton-Seed Oil.

AN abstract of an article by P. L. Simmons, F. L. S., in *American Journal of Pharmacy* and reprinted in *Scientific American Supplement* (June 8) is given in this review. The author claims the merit of being the first to suggest the production of cotton-seed oil, in a lecture delivered 40 years ago before the Society of Arts and Manufactures in London, of which lecture "The Utilization of Waste Products" was the theme.

"At the time this suggestion was made, of utilizing cotton seed for oil, in 1855, the United States production was less than 1,250,000,000 pounds; now the production has risen to about 3,500,000,000 pounds. The first shipment of cotton-seed oil in the year ending June, 1872, was but 547,165 gallons, and few would have anticipated that it would reach in 1892 the enormous export of nearly 14,000,000 gallons, worth nearly $14,000,000. The various forms of cotton seed all yield good oils capable of being refined for dietetic use. The oil possesses excellent lubricating qualities, and is useful for soap-making and for lamps. The quantity of oil produced, even in England, is large, the imports of cotton seed exceeding in some years 400,000 tons. In the States the production of seed exceeds 3,000,000 to 4,000,000 tons, of which half is available for oil; 100 lbs. of seed will yield 2 gallons of oil. There are four qualities of oil made. The crude oil varies from a dirty yellow to a reddish color; on standing, it deposits a slimy sediment. The second quality has a pale orange color, and is obtained by refining the crude oil with a solution of caustic soda. The yellow oil resulting from this process is further purified by being heated and allowed to settle again, or by filtration, and is called 'yellow summer oil.' 'Winter yellow oil' is made from the above material by chilling it until it partially crystallizes, and separating the stearin (about 25 per cent.) in presses, similar to those used for lard. This is then treated with Fuller's earth in a tank, which holds back the coloring matter, and the oil which issues from the filter press is almost white. In 1896 there were probably 1,250,000 tons of cotton seed crushed in the United States. From this seed there were obtained 1,000,000 barrels of oil. It is estimated that 300,000 barrels were used in Chicago for making oil lard; and that St. Louis, Kansas City, and Omaha took 200,000 for the same purpose. About 250,000 barrels went to Holland for making margarine, and large quantities to Southern Europe for mixing with olive oil. Cotton-seed oil seems to be useful for table purposes, and it is desirable that its use in the pure state, rather than as a mixture, should be encouraged. It ought, however, to be sold on its merits, and with the addition of some qualifying term, which will indicate its origin. This oil has entirely replaced olive in America, and in London and Paris restaurants.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

†32393. How is Vulcanization Accomplished? (Ind Rub Wld–June 10.) 900 w.

†32395. The Mitchell Patents Not Infringed Upon.—Suit of Chemical Rubber Co. v. the Raymond Rubber Co. (Ind Rub Wld–June 10.) 1500 w.

We supply copies of these articles. See introductory.

†32396. Interlocking Rubber Tiling on the "St. Louis." Ill. (Ind Rub Wld–June 10.) 500 w.

*32413. The Teak Trade of Siam. From report of Mr. Black (*Arch*–May 31.) 3500 w.

*32427. The Life-History of the Crustacea in Early Palæozoic Times. Henry Woodward (*Nature*–May 30.) 5600 w.

†32457. Some Notes on Molecular and Atomic Refraction. W. F. Edwards (Am Chem Jour–July.) 4800 w.

†32458. A New Apparatus for Determining Molecular Weights by the Boiling-Point Method. I. H. B. Hite. II. W. R. Orndorff and F. K. Cameron (Am Chem Jour–July.) 4800 w.

†32492. The New Element of the Atmosphere. Considered by Lord Rayleigh (New Sci Rev–Jan.) 1200 w.

†32497. The Elements. William Crookes (New Sci Rev–April.) 2500 w.

†32499. The Ether and Its Functions. George Frazer Fitzgerald (New Sci Rev–April.) 4800 w.

†32502. The Operation of the Vibratory Circuit. John W. Keely (New Sci Rev–April.) 2500 w.

32517. Industrial Progress in the Arts. A. V. Newton (Inv Age–June.) 4600 w.

*32565. Scientific and Technical Societies. Editorial (Engng–June 7.) 2500 w.

†32648. Geological Sketch of Florida. E. T Cox (Tr Am Inst Min Eng–June.) 3000 w.

32663. Impressions of Japan. E. C. Potter (Ir Age–June 20.) 2000 w.

*32743. Argon. Lord Rayleigh (*Nature*–June 13.) 7000 w.

32785.—$1.50. The Topographic Map of the United States. Ill. Herbert M. Wilson (Am Soc Civ Eng–May.) 5200 w.

†32787. Picturing the Planets. Ill. James E. Keeler (Cent Mag–July.) 5300 w.

32815. Cold on Tap (Mas St Fit–June.) 450 w.

†32829. The Bowels of the Earth. Alfred C. Lane (Pop Sci M–July.) 4200 w.

32839. Lord Kelvin. Ill. Arthur Warren. Extracts from Pall Mall Gazette (Elec Wld–June 29.) 2000 w.

†32867. On the Correlation of New York Moraines with Raised Beaches of Lake Erie, Frank Leverett (Am Jour of Sci–July.) 8000 w.

†32868. On Some Compounds Containing Lead and Extra Iodine. H. L. Wells (Am Jour of Sci–July.) 2000 w.

†32869. The Estimation of the Halogens in Mixed Silver Salts. F. A. Gooch and Charlotte Fairbanks (Am Jour of Sci–July.) 1800 w.

†32870. On the Pitch Lake of Trinidad. S. F. Peckham (Am Jour of Sci–July.) 7000 w.

†32871. On Some Reptilian Remains from Triassic of Northern California. Ill. John C. Merriam (Am Jour of Sci–July.) 700 w.

†32872. A Further Contribution to our Knowledge of the Laurentian. Ill. Frank D. Adams (Am Jour of Sci–July.) 5000 w.

*32892. The Metric System of Weights and Measures. G. H. Baines (*Col Guard*–June 21.) 1200 w.

*32914. A Standard of Sound. Hiram S. Maxim (*Engng*–June 14.) 1000 w.

32974. The Descent of Man. Edward Drinker Cope, in N. Y. Herald. (Sci Am Sup–July 6.) 2000 w.

*32991. Engineers of To-day and Yesterday. Frank William Webb. Ill. (*Eng Rev*–June 20.) 1200 w.

*33013. The "Distress of Nations." James M. Beck (Am Mag of Civ–July.) 9000 w.

*33014. The Citizen a Sovereign. Wilmot H. Goodale (Am Mag of Civ–July.) 3000 w.

*33015. Ought We to Annex Cuba? A Symposium (Am Mag of Civ–July.) 5000 w.

*33018. The Public Schools and Good Citizenship. Charles R. Skinner (Am Mag of Civ–July.) 2400 w.

†33019. Remarks on the Genus Nanno, Clarke. Ill. Alpheus Hyatt (Am Geol–July.) 3800 w.

†33020. Steps of Progressive Research in the Geology of the Lake Superior Region Prior to the Late Wisconsin Survey. N. H. Winchel (Am Geol–July.) 2800 w.

†33021. Actinophorous Clarki, Newberry. Ill. E. W. Claypole (Am Geol–July.) 1900 w.

†33022. Camptonites and Other Intrusives of Lake Memphremagog. Vernon F. Marsters (Am Geol–July.) 4300 w.

†33023. The Kame-Moraine at Rochester, N. Y. Ill. H. L. Fairchild (Am Geol–July.) 4000 w.

*33035. Technical Research. Editorial. (*Engng*–June 28.) 2800 w.

*33063. Periodic Functions Developed in Fourier Series—The Graphical Method. John Perry (*Elect'n*–June 28.) 700 w.

†33076. India-Rubber as an Agent of Civilization. Gustav Heinsohn (Ind Rub Wld–July 10.) 1400 w.

†33077. Carriage Wheel Tires in England. Ill. Joseph T. Wicks (Ind Rub Wld–July 10.) 700 w.

†33078. The Question of Tire Guarantees. Hawthorne Hill (Ind Rub Wld–July 10.) 2200 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (*Prac Eng*–Began Aug. 10, 1894—21 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making. (Sta Eng–Began Nov., 1894—7 parts to date—15 cts. each).

29531. A History of the Last Quarter-Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag–Began March—5 parts to date—30 cts. each).

31336. British Fuses for Modern Guns. Ill. (*Eng*–Began April 19—Ended June 7—2 parts—30 cts. each).

32657. Colorado Marble. George C. Underhill (Stone–Began June—1 part to date—30 cts).

We supply copies of these articles. See introductory.

COMMENT & CRITICISM

Anchor Ice.

IN your April number Mr. Frank S Mason contributes a theory as to anchor ice which involves the formation of ice crystals having a temperature of 16° F. near the upper surface of water at 32° F. The physical qualities of ice forbid the acceptance of this assumption without the clearest experimental proof that it is a fact.

Ice is a conductor of heat. It is true that, compared with many other substances, its conducting power is small, but that it is a conductor must be admitted. Otherwise it would be impossible to freeze solid cakes of ice in metallic moulds, as is done every day in artificial ice-making. In this operation the water does not freeze from the top, as in rivers, ponds, and lakes, but from the bottoms and sides; and the central core of water can be finally congealed only by the passage of heat through the solid ice previously formed. This is strictly a process of conduction. The law of heat conduction is that the rapidity with which heat passes through a conducting body is inversely as the thickness. That is to say, the thinner the conducting body is, the more rapidly will heat motion penetrate the mass. The crystals or spicules of ice which mark the initial point of the freezing of water are extremely thin, and it could be proved mathematically that, if such spicules at 16° F. were cast into a large body of water at 32° F., they would assume the latter temperature before they could have time to sink even a few inches, to say nothing of a few feet.

The sinking of such spicules would be extremely slow, even were it possible to maintain their temperature while sinking, the difference between their specific gravity and that of water not being sufficient to compel rapid sinking. Again, it is well known that small particles of even much heavier bodies than water sink slowly and with difficulty, owing to the large surface resistance in proportion to their total weight. I have frequently seen particles of gold crystals float on the surface of water. The precipitation of heavy solids in a finely-divided state from aqueous solutions often requires hours, and even days, in laboratory work.

For these reasons I cannot accept Mr. Mason's theory of the formation of anchor ice. I think the phenomenon is wholly due to regelation of ice at 32° F., in water agitated sufficiently to intermingle the ice crystals with it at varying depths of submergence.

LEICESTER ALLEN.

Brooklyn, July, 1894.

Hydraulic Engineering.

IN connection with your recent remarks on Indexes (January issue), it may be of interest to you that I have here a card index of hydraulic engineering, which now contains over 8000 cards and includes both book and periodical literature;—also a topical index of the subject, without references, in dictionary form, giving the subjects or headings in alphabetic order, with cross-references, and an analysis of each important heading, as *canals, rivers, water supply, &c.* The latter now covers about thirty pages of type written foolscap, and is growing.

I am willing and anxious to make this index of general use, and would be glad to coöperate with anyone in any desirable way. It would give me pleasure also to show the index at any time, or to describe my work in this connection in detail.

GEORGE D. COLTON.

Collinsville, Conn., June 20.

Parks, Parkways, etc.

THE paper on "Parks, Parkways, and Pleasure Grounds," in your May number, is the most extraordinary production in many respects that I ever read, and I have read such things all my life.

How any man can in one breath recommend that each member of a governing body shall be grounded in the "truth" of landscape, and that "it is not necessary or even advisable" that a resident superintendent shall have a thorough horticultural training, is inexplicable.

I have not time to enter upon a full criticism, but I will say that there are numbers of men in America, even in Massachusetts, who know plagiaristic styles when they see them, and who also know that barberries, buckthorn, and privet are not necessarily foreign, and, when they are, are naturalized completely.

It is a most extraordinary assumption on the part of your correspondent that no city other than New York can afford to pay competent men.

I feel absolutely certain there are a dozen men to be had in the country, any one of whom would serve permanently for from $2000 to $5000 per year.

I am not certain, however, that any one of them could be induced to serve such political hucksters and busybodies as constitute "governing bodies," on any terms.

JAMES MACPHERSON.

Trenton, N. J., July 6.

Wood Stave Pipe.

IN the June number of your magazine we notice an article by A. Lakes on wooden stave water pipe, in which he claims that it is the invention of a Mr. Allen. We write to state that the idea is as old as the hills. While we admit that the west is a great country, we of the east still have some "ideas" left.

Nearly 30 years ago we made wood stave water pipe, having had a three-sided planer built expressly to plane the staves. Our pipes run from 30 in. to 60 in. in diameter, and from 50 ft. to 400 ft. in length; and, when used to convey water from our dams to the water-wheels at the powder mill, the hoop we use is far superior to that employed by Mr. Allen. We had a cast-iron block made and cored for rod-ends the rod having two nuts, which make it much better than a rod with only on nut. We have seventeen water-wheels, and are using wood pipe for each wheel. Allen's pipes are miles long, and ours are short, but the "idea" is the same.

H. A. WELDY & CO.

Tamaqua, Pa., June 5, 1895.

Low Prices for Iron Ores.

IN the excellent paper on "The Advance in Modern Iron Smelting," published in the June number of THE ENGINEERING MAGAZINE, I was surprised to note that Mr. John Birkinbine failed to take into consideration the low cost of iron ore, when discussing the wonderful output and cheapness of American pig iron. There is no one factor, within my knowledge, that has so greatly tended to reduce costs as the prices for ore. Within 5 years they have fallen from $5.50@$5.75 to $2.75@$3.00 per ton for bessemer ore at Cleveland, O., which means a difference of nearly $5.00 per ton of pig. What other single item has been reduced an equal amount?

S. S. F.

Chicago, June 10, 1895.

An Error.

ON p. 397 of your issue for May, Nemo, in "Comment and Criticism," makes an error I am sure you would wish to correct, —*viz.*, the paper that stole Dr. Emery's article is *The Indian Engineer*, NOT *Indian Engineering*.

I am not interested in either of the papers; so may add that I happen to know that the proprietors of *The Indian Engineer* are merely advertising agents, who got the paper by a shabby trick from the former owner, and who conduct it entirely by the aid of scissors. No engineers in India read the thing, and I suppose it runs on the money of too confiding English advertisers.

R. T.

Lyncroft, England, June 20, 1895.

[We regret that the mistake made by our correspondent "Nemo" in the letter referred to should have been undiscovered before publication. We offer apologies to *Indian Engineering* for this oversight. —THE EDITOR.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

The New Process Raw Hide Co., Syracuse, New York, U. S. A.=Catalogue, 94 pp., 3½″×6″. [Describes and illustrates the new process, raw hide, noiseless solid spur, bevel and friction gears, washers, etc., etc , manufactured by this company. Also a line of raw-hide bound mallets and chisel handles. Cover, robin's-egg blue and black.]

The Arthur Company Machine Works, New York, U. S. A.=Illustrated price-list, 32 pp., 5¾″×8¾″. [Cover, dark blue and black.]

Speidel & Roeper, Reading, Pa., U. S. A.=Catalogue, 28 pp., 4½″×7½″. [Describes and illustrates the "Patent Economic" safety hoists manufactured by this company, of capacity 500-30,000 lbs, includes portable hoists, overhead tramways, travelling cranes, portable derricks, stationary hoists, and cellar hoists.]

The Torrey Roller-Bushing Works, Bath, Me., U. S. A.=Catalogue and price list of bushing and sheaves, hoist wheels, composition sheaves, washers, binnacle bells, fog bells, windlasses, side lights, zinc letters, water marks, manrope stanchions, well wheels, and brass finished deck-plates manufactured by this Co.]

Fred J. Meyer, 22 Beekman St., N. Y., U. S. A.=Catalogue 7 pp., 6″×9″. [Paper boxes.]

Keuffel & Esser Co , New York, U. S. A.=Pamphlet, 27 pp., 9″×6″. [Describing the "Pilot" File System for binding, indexing, and arranging letters and other documents. The system comprises a variety of appliances, all of which are illustrated and described.]

The Norwalk Iron Works Co ,Norwalk,Conn., U. S. A.=Pamphlet, 32 pp., 7″×9″, entitled "A Few Facts Concerning Machines for Pumping Natural Gas." [Contains a large amount of practical and useful information upon this subject. One of the tables has seemed of sufficient importance to be re-printed in our department of mechanical engineering, which see.]

The Avondale Marble Co., Avondale, Pa., U. S. A.=Pamphlet, 12 pp., 4½″×7″. [Describing the building, bridge, and dimension stone from the Echo quarry of the Avondale Marble Co. Contains analyses, both mineralogical and chemical, made by eminent scientists, absorption tests performed in various technical laboratories, tables of crushing strength, crushing tests performed by authoritative experimenters, etc. These reports and tests emphasize the wide difference that may exist in stones as well as in other constructive materials.]

The New York Belting and Packing Co., New York, U. S. A.=Catalogue and price-list, 96 pp., 5½″×8½″. [Describes and illustrates one of the largest lines of rubber goods carried by any house in the world. Also a line of Vulcanite Emery wheel goods, hose pipes, sprinklers, etc.]

The Jeffrey Mfg. Co., Columbus, O., U. S. A.=(1) Catalogue, 144 pp., 5″×7½″. [Describes and illustrates a line of chain belting, steel cable conveyors, labor-saving appliances, elevators, conveyors, carriers, power-transmission machinery, mill, factory and mine supplies and mining machinery, manufactured by this company.] (2) Catalogue, 48 pp., 10¾″×7¾″. [Illustrating and describing the Jeffrey patented coal-mining machine-drills, electric mine locomotives, elevating and conveying machinery and complete coal-mine equipments. This catalogue is beautifully printed and illustrated, and contains a department of useful and general information relating to various practical details of mine engineering, including general information relating to electric dynamos, motors, and wire, and concluding with a table of dimensions of resistance of pure copper wire.]

The American Boiler Co , Chicago, Ill., U. S. A.=(1) Pamphlet, 12 pp., 9″×6″. [Describes and illustrates the "Advance" hot-water heater for warming residences and other buildings by hot-water circulation, with tables of capacities and dimensions.] (2) Pamphlet, 20 pp., 9″×6″. [Describes and illustrates the "Tropic" hot-water heater for warming residences and other buildings, manufactured by this company, with list of buildings in which the heater is used, and tables of capacities and dimensions.] (3) Leaflet, 4 pp , 9″×6″. [Describing and illustrating the "Modern" safety sectional steam boilers for hard or soft coal, and for heating all kinds of buildings.]

The Link-Belt Engineering Co , Nicetown, Philadelphia, Pa., U. S. A.=An album of blue prints, 32 sheets, 10″×8″. [This is an exceedingly interesting collection, illustrating coal handling in locomotive coaling stations (of which a large variety of illustrations are given), and, also, industrial, electric-light, and street-railway-car plants erected by this company. Descriptive text for each of the illustrations is printed on the margin of the sheet. The collection represents the most modern advances in coal handling and coal conveying, and will repay close examination by those who wish to be well informed upon this subject.]

The Deming Co., Salem, Ohio, U. S. A.=Catalogue, 232 pp., 7″×10″, bound in stiff cloth covers. [This is a very important catalogue, the alphabetical classified index of which occupies nearly three full pages, including classes of goods only. It describes and illustrates a long line of hydraulic goods, including iron and brass pumps for hand, wind-mill, and power use, hydraulic rams, artesian well brass cylinders, pump fixtures, well tools and supplies. Besides describing and illustrating this line of goods, the book contains a great deal of practical information, some of it in tabulated form, relating to water discharged per minute at different elevations, figures and formulas which will assist in ready calculation of hydraulic problems, tables of sizes of pipe fittings, etc.]

The Adams Boiler Co., Cleveland, O., U. S. A.=Pamphlet, 11 pp. [Discusses the advantages of heating feed water for boilers, and also describes and illustrates the Adams feed-water heater and purifier, with testimonials from those who have used this feed-water heater.]